

REVIEWED: THE NEW SURFACE LAPTOPS

2006

Xmas 2019
Issue 475

YOUR EXPERT

GUIDE TO TODAY'S TECH

INTEL &
AMD MODELS
HEAD TO
HEAD

**GAMING
POWER CARD
FACE OFF:**

RADEON VII vs. RTX 2080
SUPER vs. RTX 2080TI

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- GOOGLE PIXEL 4**
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STEP-BY-STEP GUIDE

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**GREAT HOLIDAY
DIY PROJECT
SAVE \$ WITH
THIS VERSATILE
BUILD**

**BEST MONITORS
UNDER 27-INCHES**

FITS YOUR WALLET AND YOUR DESK

**HOST YOUR OWN
PASSWORD SERVER**

TAKE CONTROL OF YOUR SECURITY

**REVIEWED
INTEL 9900KS
5GHZ CPU**

PLUS: ASUS ZENBOOK FLIP 13
NVIDIA GTX 1660 SUPER
ACER CONCEPT D
BANANA PI PRO
+ MUCH MORE

9TH GEN
Core i9
UNLOCKED
SPECIAL EDITION

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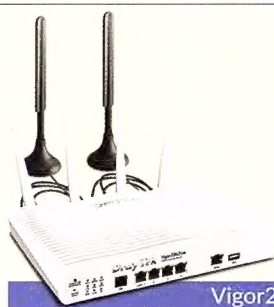


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Supports 4G LTE bands: B1/B3/B5/B7/B8/B28/B40 (Bands vary pending models)
Great coverage in Australia and New Zealand

- Provision of Internet access on public transport such as coaches, buses, trains, freighters, etc.
- Temporary installations such as disaster recovery and emergency situations, exhibitions, sporting events, etc. where Internet access is required for a short period.
- Quick setup for remote location or new branches waiting for xDSL/Ethernet WAN (e.g. NBN).
- Multi-WAN series LTE routers (i.e. Vigor2862L, Vigor2926L) support Load Balancing and Failover functions.
- Single WAN series LTE routers support failover functions between xDSL/Ethernet/LTE connections for Vigor2620L, or between Ethernet/LTE connections for VigorLTE 200n.

Vigor2862 LTE Series



Vigor2862Lac

- 4G LTE Multi-WAN router with SIM card slot
- VDSL2/ADSL2+, 1 x configurable GbE WAN/LAN port, 1 x USB port for 3G/4G LTE Modem
- SPI Firewall, 802.11ac Wave 2 Wi-Fi
- 16 x VLANs, 32 x VPN tunnels (including 16 x SSL-VPN tunnels)
- Central VPN Management
- Central AP Management
- Support VigorACS 2 (Central Management System) for remote management

Vigor2926 LTE Series



Vigor2926Lac

- 4G LTE Multi-WAN router with SIM card slot
- 1 x GbE WAN ports, 1 x configurable GbE WAN/LAN port, 1 x USB port for 3G/4G LTE Modem
- SPI Firewall, 802.11ac Wave 2 Wi-Fi
- 16 x VLANs, 50 x VPN tunnels (including 16 x SSL-VPN tunnels)
- Central VPN Management
- Central AP Management
- Support VigorACS 2 (Central Management System) for remote management

Vigor2620 LTE Series



Vigor2620Ln

- 4G LTE router with dual SIM card slots (SIM slot 2 for failover)
- VDSL2/ADSL2+, 1x configurable GbE WAN/LAN port
- 1 x GbE LAN port
- SPI Firewall
- 802.11n Wi-Fi
- 2 x VPN tunnels including SSL-VPN
- Central AP Management
- Support VigorACS 2 (Central Management System) for remote management

VigorLTE 200n



VigorLTE 200n

- 4G LTE router with dual SIM card slots (SIM slot 2 for failover)
- 1x configurable GbE WAN/LAN port
- 1 x GbE LAN port
- SPI Firewall
- 802.11n Wi-Fi
- 2 x VPN tunnels including SSL-VPN
- Central AP Management
- Support VigorACS 2 (Central Management System) for remote management

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In pursuit of performance...

... and a nice round number.



We were hoping to have Intel's 10th gen HEDT CPUs in this issue, but unfortunately our samples arrived ever so slightly too late to do a proper job of testing, so we'll have that covered in the next issue. If you're considering an

upgrade to one of these, you'll also be needing an X299 motherboard – so that's something we were able to get into this issue. The main motherboard companies are all refreshing their X299 boards for Intel's 10th gen release and we have a sampling for you to enjoy and consider.

It's not all about 10th-gen. After hyping it up at Computex back in June this year, the premium i9-9900KS CPU landed... in our Labs. Chris has been giving it a good workout and the review is on page 34. This beast has been rigorously tested and binned by Intel and it's the best quality silicon the company is able to produce, with the CPU sitting comfortably on 5GHz for every one of its eight cores. This is a rare product that is intended for enthusiasts and gamers, and more than likely those that aren't inclined to do their own overclocking. That

said, the 9900KS still has some headroom for even more performance – depending on the luck of the draw, of course.

Just how your fortune falls when buying a new CPU is still random, as it's always been – some CPUs are simply more tolerant of above-spec frequencies and voltage. We all know that. But if you absolutely must have a CPU that's better than the rest, and want to look beyond Intel or AMD's market-driven product stack structure, there's always Silicon Lottery (siliconlottery.com). This lot buy many CPUs at a time, then test every single one for maximum OC headroom – then sell them for a markup ranging from reasonable to insane. I love it. They're pre-overclocked by pros with a guaranteed level of above-average performance. What a great idea for a VERY niche business.

I hope your world is calm and stress-free in the lead-up to Christmas, and that the impending break is long and wonderful. See you in a month.

BEN MANSILL
EDITOR
ben.mansill@futurenet.com

"This beast has been rigorously tested and binned by Intel and it's the best quality silicon the company is able to produce"

exclusive software

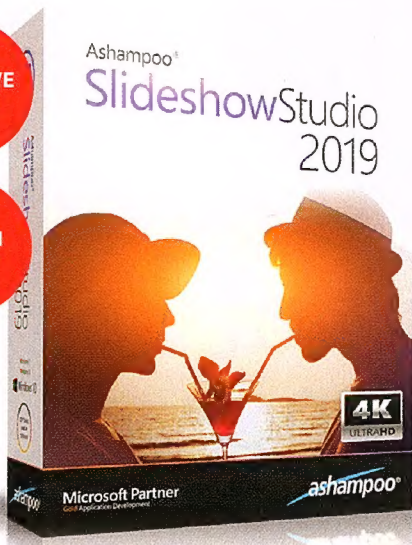
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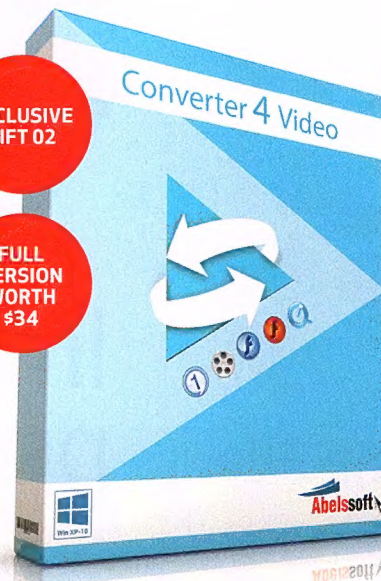
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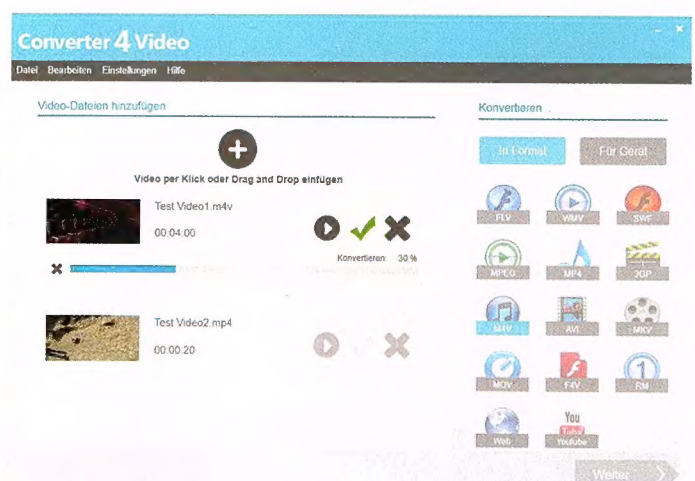
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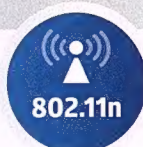


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- SAVE \$ WITH THIS VERSATILE BUILD



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TAKE CONTROL OF HOW YOUR PASSWORDS ARE SYNCED AND WHERE THEY'RE STORED, WITH NICK PEERS.

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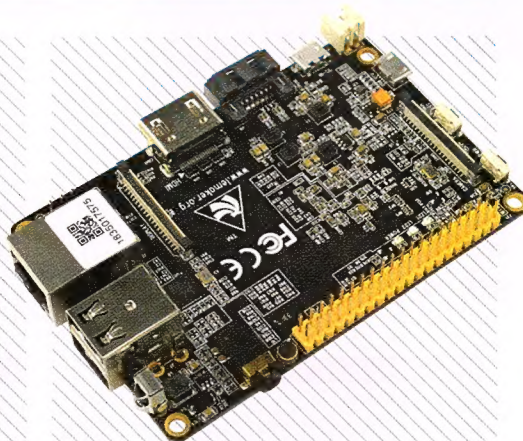
"If \$2,000-plus motherboards start to be accepted as normal, then the market has lost the plot.." *page 18*



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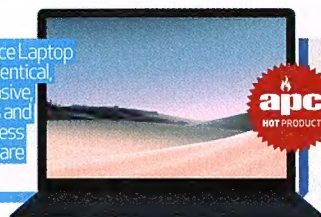
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» LATEST REVIEWS

"Both the Surface Laptop 3s come with identical, soft and responsive, glass trackpads and square ten-keyless keyboards that are easy to use!"

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Microsoft Surface Laptop 3 13-inch & 15-inch

Microsoft has pitched AMD and Intel in a laptop battle royale by powering each new Surface Laptop 3 with competing CPUs. So which one comes out on top in this defining battle for laptop supremacy?

With AMD dominating the desktop CPU space this year, Microsoft has given it the opportunity to compete against Intel in the new Surface Laptop 3. AMD was given the task of designing a custom CPU for the 15-inch Surface Laptop 3, while Intel was delegated the task of driving the less expensive 13-inch clamshell with the iconic Alcantara keyboard surround a returning feature of the Surface Laptop 2. The 13-inch laptop actually offers additional Sandstone metal and Cobalt Blue Alcantara colorations for those that want to be a little more adventurous with colouring.

ON THE SURFACE
Both the Surface Laptop 3s come with identical, soft and responsive, glass trackpads and square ten-keyless keyboards that are easy to use. This combined with the device's USB 3 Type-A, USB 3.1

Surface Laptop 3s, so there are a lot of consistencies across the units. Both the 13-inch and 15-inch models offer a Black all-metal chassis or a Platinum metal clamshell with the iconic Alcantara keyboard surround a returning feature of the Surface Laptop 2. The 13-inch laptop actually offers additional Sandstone metal and Cobalt Blue Alcantara colorations for those that want to be a little more adventurous with colouring.

ON THE SURFACE
Both the Surface Laptop 3s come with identical, soft and responsive, glass trackpads and square ten-keyless keyboards that are easy to use. This combined with the device's USB 3 Type-A, USB 3.1

Type-C, 3.5mm headphone jack and Surface Connect ports make it really versatile against some competitors – since you don't need an additional dock. While there's no fingerprint reader, Windows Hello Face is quick and secure enough to make for an easy sign-in process. If you look at the general display specs, both the monitors share the same 10-point multitouch PureGloss Touchscreen display in a 3x2 aspect ratio with a 220 PPI pixel-per-inch resolution. The smaller model has a 13.5-inch screen and an unusual 2256 x 1504 pixel resolution while the 15-inch version's resolution is slightly higher at 2496 by 1664 pixels. This is definitely the sweet spot for laptop displays since it offers greater clarity for

documents without taking the battery hit that you get by going full 4K. The screens look vibrant with an average brightness around the 400 nit mark, and while you do get access to Windows 10's HDR video streaming options in both variants, the screens can only reproduce around 63.4% of the Adobe RGB colour profile – so it's not ideal for creatives or HDR playback.

ON THE SURFACE
On the surface these two devices are identical in many ways, but because of the use of two distinct CPU architectures they are actually very different. Both the 13-inch and 15-inch Surface Laptop 3 devices can be configured with a choice of two processors from their

Intel Core i9-9900KS

Asus Crosshair VIII Impact

Thermaltake Floe DX RGB 360 Premium Edition

Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

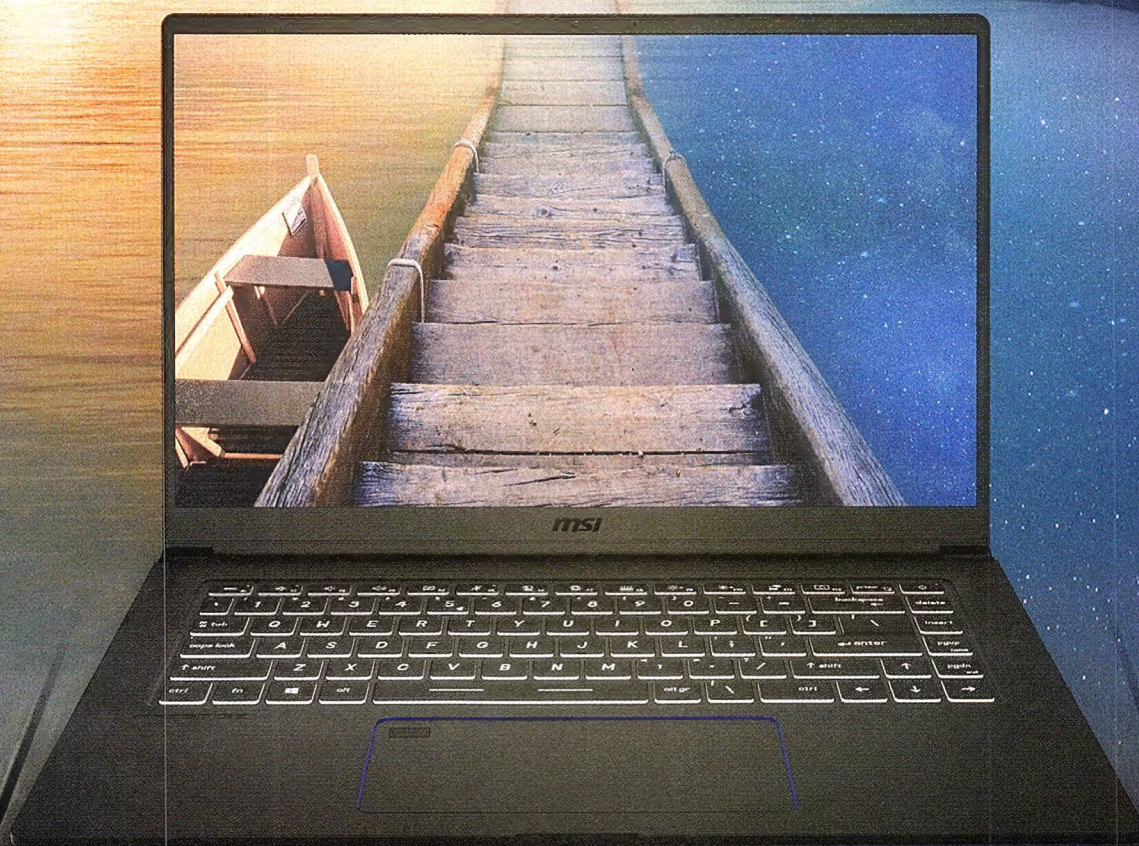
As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

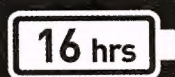
We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.



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Google Play Pass gets underway in US

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Priced at US\$5 per month, Google has a catalogue of over 350 games and apps at launch that work with Play Pass. For those products, you get every in-app purchase, every expansion pack and every paid feature of the apps and games you're using – and you'll never see an ad, either. After the U.S. trials Play Pass is expected to launch in Australia.

Chrome could soon tag and shame slow-loading websites

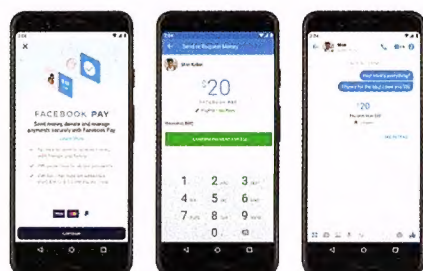
GOOGLE RECKONS "THE WEB CAN DO BETTER".

Google Chrome could soon apply badges to websites that load particularly slowly to encourage their owners to make some changes and speed things up. The browser will look for sites that are built in a way that makes them particularly sluggish using historical data, and in the future it may also factor in the predicted load time based on the device and network conditions.

Facebook takes on Apple Pay with its own service

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It will eventually allow you to make payments across the company's four major platforms – Facebook, Messenger, Instagram, and WhatsApp – but is limited to just Facebook and Messenger at the time. You'll need to go to the Facebook Pay section of either app's settings page in order to enable the payment service. It's also restricted to just the U.S. at launch, though the company is promising a wider rollout in the future.



AMD launches top-end 16-core Ryzen 9 3950X and new Threadrippers

PLUS A SURPRISE BUDGET CPU.

AMD is set to close out the year on a high note. As promised, the company will be delivering its latest 16-core Ryzen 9 3950X processor, built with two 7nm TSMC chiplets, to the consumer platform for US\$749. Not only this, but AMD has lifted the covers on its next generation Threadripper platform, which includes Zen 2-based chiplets, a new socket, and an astounding 4x increase in CPU-to-chipset bandwidth.

The announcement revolves around several parts, in completely different markets: Ryzen 9 3950X, TR 3960X and TR 3970X, new TR40 motherboards, and the budget Athlon 3000G.

One key takeaway from the announcements is how AMD is moving the traditional desktop and high-end desktop markets. When CEO Dr. Lisa Su was asked earlier this year what will happen to Threadripper as the mainstream Ryzen family adds performance, her response was that "Threadripper will move up". To that effect, we are seeing AMD's delineation between mainstream desktop and high-end desktop move up to between 16-core and 24-core, with room at the top for more cores if AMD wants to go that way.



WhatsApp co-founder still thinks we should delete Facebook

FORMER BOARD MEMBER STANDS BY DECISION TO LEAVE.

While it has been almost two years since news of the Cambridge Analytica scandal first broke, WhatsApp co-founder Brian Acton still thinks that users should delete Facebook. At Wired's 25th anniversary summit, Acton told a crowd that others should make their own decisions about leaving the social network though he stands by his decision to leave, saying: "If you want to be on Facebook and you want to have ads thrust in front of you, go to town." Acton's fight against Facebook began in March of 2018 when he took to Twitter to tell others "It is time" followed by the hashtag #deletefacebook. When he tweeted that message, Acton had been away from Facebook for more than a year after he stepped down in 2017 over a disagreement regarding monetizing WhatsApp. Following his departure from WhatsApp, Acton went on to co-found the Signal Foundation. Its titular encrypted messaging app is now used by journalists and human rights advocates around the world.



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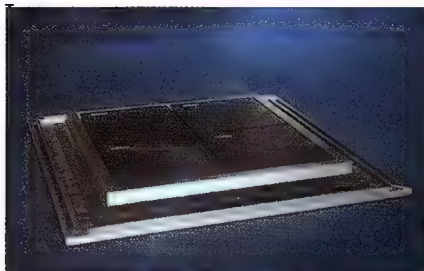
GIGABYTE™



Apple's new 16-inch MacBook Pro almost cracks \$10k

SPEND A LITTLE MORE THAN TEN BUCKS ON A CASE, WE RECKON.

Apple recently announced that a new 16-inch MacBook Pro would be taking the place of its 15-inch model, but with this new screen size comes a new extreme price. If you want to fully spec it out, you'll be looking at \$9,679 worth of laptop. This nets you a ridiculous 8TB of SSD storage and 64GB of RAM, amongst other things.



Intel's Atom lives on

THE CHEAPEST CHIP.

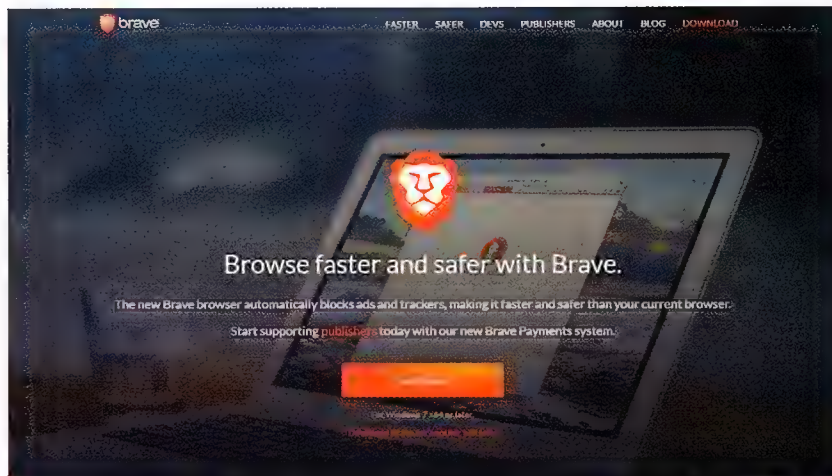
The first revamped Atom CPU is expected to be seen in new low-powered devices soon – possibly before the end of this year. The Lakefield CPU is the first of the new family and is intended for laptops. Built using a 10nm+ process, it uses a new x86 core called Tremont, and is a quad-core design with power consumption as low as 1.5W.



Intel Cascade Lake CPUs hit by security flaw

DATA THEFT VIA ZOMBIELOAD 2.

ZombieLoad attacks were first detected in May 2019, when it was discovered they could use malicious program to steal sensitive data from memory locations that normally they could not access. Now, a second generation, ZombieLoad 2, has been found to be able to get around the defences put in place after the initial attacks, accessing data on 10th-gen Intel Core and 2nd-gen Intel Xeon CPUs.



Tracker-blocking browser Brave comes out of beta

FIRST STABLE LAUNCH OF 'PRIVACY RESPECTING' BROWSER.

Brave is a web browser that promises to maintain the privacy of its users, protecting them from a variety of third-party ads, autoplaying videos, and trackers. Since launching the beta in January 2016, Brave was drawing in eight million monthly users before it officially let loose its first stable release. A good majority of web ads include some form of tracker that ties your identity to your browsing habits in order to better target you for advertising, and Brave blocks these.

While users may rejoice at the idea of not being fed any intrusive advertising, ad-blocking does negatively affect the websites that serve those ads. Brave is claiming to offer a solution to this imbalance via a rewards program in which users can earn tokens by "viewing privacy-respecting ads" and give them to the websites they visit most. The user is able to opt-out of giving tokens to certain websites of their choosing and can also send them directly to their favourite content creators – a YouTuber, for instance.

Google might be planning a move into banking

SEARCH GIANT PLANS TO PARTNER WITH BANKS TO OFFER CHECKING ACCOUNTS.

According to a report from *The Wall Street Journal*, Google is currently working on a project, code-named Cache, which will see it move beyond payments and into the banking space. VP of product management at Google, Caesar Sengupta explained that the company does not intend to sell customers' data but instead it wants to help users handle more of their finances online, saying: "If we can help more people do more stuff in a digital way online, it's good for the internet and good for us." Google isn't the only tech giant to look into this move, with Apple recently launching its Apple Card through a partnership with Goldman Sachs and Amazon reportedly in talks with JP Morgan Chase to create a checking account for its customers.

While details surrounding Google's move into banking are still scarce at the moment, expect the company to say more as we get closer to the official reveal.



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H200 BLACK & SNOW
RGB TEMPERED GLASS CASE



Windows 10X: Everything we know so far

Windows 10X is launching next year on a new wave of foldable PCs. Let's see how Microsoft is adapting its OS for this new form-factor.

Windows 10X is a new version of Windows 10 that Microsoft says has been built from the ground up for foldable PC experiences in both dual-screen and single-screen configurations.

It's built on top of a new modern version of Windows 10 that guts legacy components and features in favour of contemporary user experiences and enhanced security. This means everything from the Windows Shell to the underlying OS has been re-done with modern technologies, while still maintaining legacy app support for those who need it.

Win32 programs, which Microsoft considers to be a legacy app platform, now run in a containerised mode on Windows 10X. This means the components required to run Win32 apps are only active when the user is actively running a Win32 program. This reduces system load when not running a Win32 application, which improves battery life and system performance overall.

Containerising the Win32 layer also makes the OS much more secure, as Win32 programs are now sandboxed and can't negatively affect system files.

Unlike the containerised Win32 programs, UWP and web apps run "natively" on Windows 10X. Users shouldn't notice a difference in performance between UWP and Win32 programs, even though the Win32 programs are being containerised on top of the OS. It's great to see that Microsoft is supporting legacy apps on Windows 10X, as many Windows apps today are still Win32.

Microsoft is hoping developers start to update their apps to support the new dual-screen and foldable screen designs that they expect to start shipping at the end of next year. A new feature called "spanning" is being introduced as an API that lets developers take advantage of the extended display capabilities from using a foldable PC.

The shell has been designed from the ground up with Microsoft's Fluent Design System in mind, meaning it's much cleaner and more consistent than the experience found on Windows 10 today. It has a new adaptive taskbar that minimises when using touch, which can be swiped up to access pinned and running programs. There's also a new Control Center that also houses system notifications, similar to

an Android smartphone.

Pinned and running apps on the taskbar are now centred instead of positioned off to the left. Apps run in full-screen, as most foldable PCs will be used as tablets first and foremost. However, there will also be a mode that allows apps to run in a more traditional windowed environment, which will be handy when using a foldable PC as a laptop.

The Start menu itself has been redesigned with productivity in mind. It features a system-wide search bar along the top, with a grid of apps below that in place of live tiles. It also has a "recommended" area that suggests things the user might want to jump straight into, such as recent Office documents and websites.

Windows 10X will only be available on devices that ship with it, and those devices will begin shipping in the second half of 2020. This means if you want to use Windows 10X, you will have to buy a new PC that comes with Windows 10X preinstalled. The OS will not be made available to purchase or download to install on existing hardware, and won't be pushed as an update for Windows 10 users either. ■

Zac Bowden



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gadgets

» GIZMOS AND GOODIES.

T-FORCE DELTA MAX SSD

Light up your data.

\$TBA 250GB, 500GB, 1TB | TEAMGROUPINC.COM

Team Group's T-Force Delta Max RGB SSD comes in a 2.5-inch/9.5-mm SATA form-factor and is based on Silicon Motion's SM2258 controller paired with Micron's 64-layer or 96-layer 3D TLC NAND memory. From a performance point of view, we are dealing with fairly standard mainstream SATA drives: the SSD is rated for up to 560/510 MB/s sequential read/write speed as well as up to 90K/80K random read/write IOPS. True to its name, the SSD features an oversized addressable RGB LED module on top that features built-in rainbow colour water flowing lighting effect and can be controlled using software from leading motherboard manufacturers.



ASUS ROG STRIX ARION PCIe SSD ENCLOSURE

NVMe SSD speeds to go. BYO SSD.

\$129 | ROG.ASUS.COM

The Asus ROG Strix Arion SSD chassis is compatible with all M.2-2280 (and smaller) drives featuring a PCIe 3.0 interface and do not have a pre-installed heat spreader (in order to fit properly inside). The SSD can be installed without using a screwdriver, so the assembly is quite easy. The enclosure is made of aluminium and has thermal pads in a bid to ensure proper heat dissipation and consistent performance. The unit is bus-powered and has a USB Type-C interface, but Asus will ship it with a USB-C-to-USB-C as well as a USB-C-to-USB-A cable to maximise compatibility.

NEW NVIDIA SHIELD

Mysterious new Tegra X1+ doing the driving.

\$TBA | NVIDIA.COM/EN-AU/SHIELD

Nvidia has updated the Shield TV with artificial intelligence-assisted upscaling, Dolby Vision and Dolby Atmos support. The company introduced its first Shield TV Pro, too, and both models feature the new Tegra X1+ processor. All of the new Shield TV models' headlining features arrive courtesy of the Tegra X1+. Nvidia said the processor offers up to 25% better performance than its predecessor. Nvidia redesigned the device with a tubular chassis designed to be a bit less ostentatious, but it also nixed the previous-generation Shield TV's dual USB 3.0 Type-A ports in the process. The new Shield TV also features just 8GB of internal storage.





ADATA HD770G EXTERNAL HARD DRIVE

It fairly glows.

\$TBA 1TB, 2TB | ADATA.COM

There are many subtle, inconspicuous portable hard drives you can buy. And, there is this. Adata has a long history of making funky-looking portable drives, and its new HD7700G ticks some important functionality boxes – it's IP68 and MIL-STD-810G 516.6-tough, so can withstand 1.2m falls and being submerged under 2m of water for up to two hours. There's also AES 256-bit encryption and it connects via USB 3.2. Adata also claim that this is the "world's first durable external hard disk with RGB lighting." So, plonk this little attention-seeker down at your next LAN party and it'll attract gawkers like mozzies to a porch light.

TP-LINK KASA WI-FI POWER STRIP KP303

Make any old non-smart thing smart.

\$79 | TP-LINK.COM/AU

We like these things. Each of the power sockets here can be an independently controlled smart outlet, so, via TP-Link's Kasa app whatever you plug into each of them can be remotely activated. It creates all sorts of convenience-potential, being able to activate things you would ordinarily need to reach out and touch. Fire up your favourite old heater before you get home, use a schedule to run your coffee machine just before you wake up, etc. Alexa and Google voice control is supported. The board also has a pair of USB ports for charging devices at 5V/2.4A.



EVE SPECTRUM

To make the perfect monitor?

\$TBA | EVE.COMMUNITY

Eve, a company that crowd-developed an alternative to Microsoft's Surface, has once again put design decisions in the hands of potential buyers to come up with the Eve Spectrum, the world's first crowd-developed gaming monitor. The plan is for a 27-inch with HDR10 as well as HDR 400 certification, 144Hz refresh, a 1ms response time and 98 percent DCI-P3 colour gamut coverage. This is also a FreeSync 2 display that is G-Sync Compatible. Part of what makes Spectrum different is the use of a brighter backlight. It also uses a different polarising technique to hit a higher contrast ratio – 1000:1 instead of 750:1.

How much motherboard do you really need?

Small motherboards?
Big prices?

It's 2019. Every day people use their compact, lightweight and portable devices. Why is it then, that the stereotype of the desktop PC is still one of the chunky box mostly full of empty space, about 50 cm high and 20cm wide?

It's all due to the ATX (Advanced Technology eXtended) standard, which goes back to 1995. It was introduced by Intel and was intended to standardise the basic PC and ensure a basic level of interoperability with a compatible system architecture. Power supply voltage specifications and connectors were also introduced. Some of the adopted sub-standards are perfectly suitable now and into the future, such as the ubiquitous rectangular I/O panel that's found on every motherboard. The ATX standard mandated a 305 x 244mm motherboard dimension that to this day is still adhered to. Other standardised form factors such as Micro-ATX and Mini-ITX came later. ATX is still by far the most common consumer DIY form factor though.

Back in the 90s and 2000s users often needed a lot of expansion slots for things like graphics, audio, USB, SATA, FireWire, modems or network cards amongst other things. Nowadays though, most of these technologies are included as standard on virtually every consumer motherboard. The majority of users simply don't need more than one expansion slot. Why is it then that ATX motherboards still dominate the market? High speed USB ports are easily capable of providing enough bandwidth for a multitude of external devices. You can do things like output high bitrate audiophile quality audio to an external amp and you can run something like 6-10 SATA and/or a couple of M.2 NVMe drives on even the cheapest motherboards.

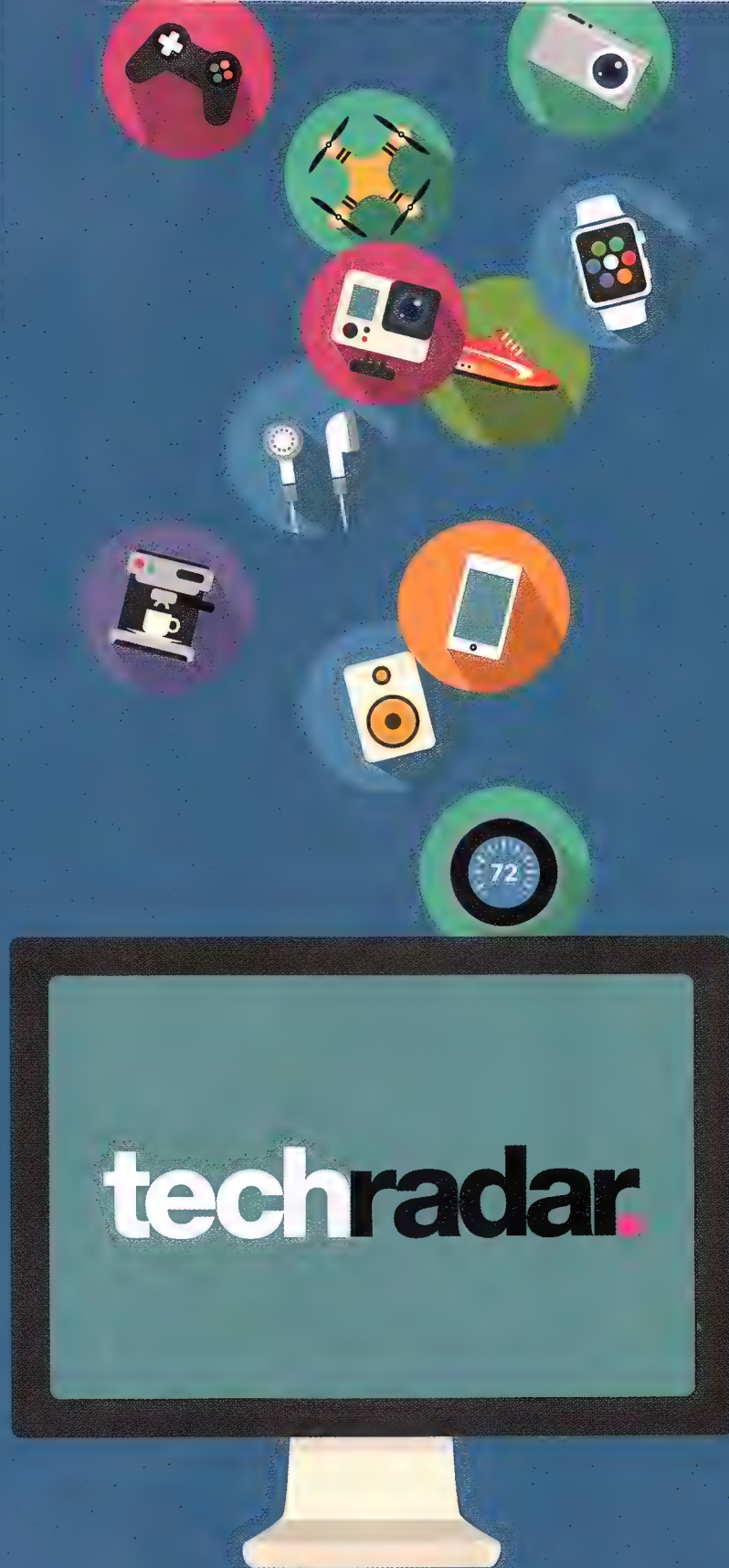


"There is something appealing about having a fully capable PC the size of a shoebox."

Additionally, there is something appealing about having a fully capable PC the size of a shoebox. You can stick a high-end eight-core or higher processor and even a full-sized graphics card into a tiny little case that performs exceptionally well at all tasks while staying relatively cool and quiet. You can even bling it out with some RGB lighting. You can game, work and multi task just as well as any ATX PC without much in the way of compromise.

So, why does the ATX motherboard make up the vast majority of motherboard sales, and hence by necessity, the chunky ATX computer case? Does the main street buyer assume a small PC is a weak PC? Do motherboard manufacturers lack the marketing will to push Mini-ITX? It remains a mystery.

Finally, a word about motherboard pricing. Gigabyte has unveiled its Aorus X299X Xtreme Waterforce (pictured above). It goes for the eye-watering price of \$2,899. That's not a typo. \$2,899 for a motherboard! Yes it has a great list of specifications and the cost of the waterblock adds a few hundred dollars, but if \$2,000-plus motherboards start to be accepted as normal, then the market has lost the plot. There are several other \$1,000 plus motherboards on the market now, and with Threadripper 3 and TRX40 coming, it's something that's unfortunately going to continue. Let's hope theoretical future X670 or Z490 motherboards don't continue this trend. \$2,000+ consumer motherboards? Put down the crack pipe! ■



The home of technology

techradar.com

Google Stadia is a great concept, but its launch is anything but promising

Google needs to simmer its cloud streaming service for a while longer, writes Shaun Prescott.

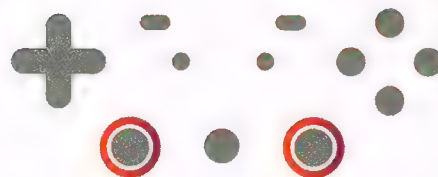
By the time you read this, Google Stadia will have launched. At least, it will have done in Europe and North America: Google's local office hasn't made a peep about a potential Australian launch, possibly due to our ropery internet infrastructure.

To summarise, Stadia is a game streaming service, but that doesn't quite capture exactly what it is. Sure, you stream game software direct from the cloud, and while it has a subscription model (there will be a free model rolling out next year with certain performance restrictions), this doesn't provide a la carte access to games in the same way Xbox Game Pass does. In other words, you still need to pay individually for each of the 20-odd launch titles like you would a regular game console, except the software isn't running locally, it's rendered remotely and the footage is streamed to your local machine.

Assuming your internet connection is good enough, this means you can stream ultra-quality games without the fuss of building a hot gaming PC. There are also options for lesser connections that offer resolutions as low as 720p. If you don't mind paying good money for software you'll never have local access to, and which you'll lose permanently should Stadia ever be discontinued, it's not a bad concept.

Except it's not a great concept straight out of the gate. Last month Stadia Director of Product Andrey Doronichev took to reddit for an 'Ask Me Anything' – basically an opportunity for internet denizens to fire off questions. It didn't leave a great taste in one's mouth. For example: any

LAST YEAR
NOTHING JUST STADIA SHIP



existing Chromecast Ultra will not support the streaming service on launch day, meaning anyone keen to jump aboard day one will need the special Founder's Edition Chromecast Ultra. Other Chromecast Ultras will be updated "soon after launch".

Meanwhile, Stadia doesn't have any family sharing functionality to speak of at launch. "Family Sharing is not supported on day one, so you'll have to buy games for your child's account," Doronichev wrote, with all the guile of a well-paid Silicon Valley luminary.

One of the greatest appeals of Stadia is the ability to play games with image quality far superior than what your personal machine is capable of. And yet, PC gamers won't have access to any of the good stuff until some time next year. "On day 1, PC Chrome gameplay won't support 4K, HDR or 5.1 Surround Sound," Doronichev said, adding that

support will roll out in 2020.

"Our approach to releasing features on Stadia is similar to how we run Google Search, YouTube and other Google services: gradual rollout and continuous improvement, based on your feedback," Doronichev wrote. All well and good when you're rolling out services that no one is paying for. The Stadia has a mandatory \$10 a month subscription fee at launch and of course, you'll need the Founder's Edition Chromecast Ultra, which is \$129. Oh, and that's sold out, by the way.

Not to mention the fairly dire launch line-up: if you're keen to play games that have been on other platforms for years, well, you're in luck! Don't expect to play the season's big blockbusters like *Call of Duty: Modern Warfare*, or *Star Wars Jedi: Fallen Order*. Overall, it feels like the Stadia needs more time in the oven. ■

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

» JOEL BURGESS STEPS INTO THE FRAY.

Google, Fitbit and the future of health data

Joel Burgess wonders if Alphabet going on a health kick?

If you've kept track of the full impact of the Cambridge Analytica scandal, or you're one of the people that tout that 'big data is the new oil', then you'll be fully aware of how powerful information on populations is and how easily it can be misused in the current regulation climate. The latest installment in the data wars concerns the announcement by Google in November that it intended to purchase Fitbit, and all the data that comes with it, for US\$2.1 billion.

Since Google's acquisition announcement was accompanied by another separate press release explicitly stating the Google has no intention of using Fitbit's health data to inform advertising, it appears that Google is infinitely more aware of the general public's concern for the dark arts of big data than a company like, say, Facebook (which we covered last month for publicly stating it didn't feel the need to fact check political advertising).

That said, the search engine giant has been far more willing to step over ethical boundaries in the last couple of years since it officially ditched the 'Don't be evil' clause as its motto and began fulfilling US military contracts for drone AI image recognition technology. And while Facebook's 'move fast, break things' ethos keeps it front and centre in the data misuse debate, Google has been shown to be capable of swaying voters in the 2016 US elections with biased search results (even if that bias was deemed to be largely unintentional by a congressional hearing in August) and it did get slapped with a US\$5 billion fine in 2018 for using its search monopoly to manipulate results for financial gain and stifle competition in Europe.

Later in November a *Wall Street Journal* article released a story on how Google has access to the detailed health records of 50 million US citizens after partnering with Ascension, the largest Catholic hospital network in the US. Project Nightingale, as the collaboration was called, became an active investigation by the Office for Civil



"Google has access to the detailed health records of 50 million US citizens after partnering with the largest Catholic hospital network in the US."

Rights the day after the *WSJ* article, since there are some stringent regulations regarding the use and sharing of patient data.

The 150 Google employees that have been working on the project over the last year have a number of objectives, but one of the more controversial is likely to be the use of patient data to create an AI treatment recommendation system to better manage patients recovery and the provided care tasks required. Since the data contains sensitive health information, diagnoses, lab results and hospitalisation records it is subject to stringent third party information sharing laws that prevent this information being used for anything other than patient treatment purposes. Google has since

made a public statement that it is "Happy to cooperate with any questions about the project" and that it believes its work adheres to all relevant regulations, but according to the *WSJ* Google is not being paid by Ascension for its services, instead intending to use the privileged patient information to develop a marketable AI patient treatment recommendation software.

While you'd really need to be a US legal expert to know if Google is skirting the law here, it's pretty clear that it is at least operating extremely closely to it. At the moment, big data seems to have a healthy outlook. ■

numbercrunch

» WE LOOK AT THE NUMBERS DRIVING THE BIG TECH NEWS.

1,585

The number of software vulnerabilities, including but not limited to those in Windows, discovered by Google's Project Zero between July 2014 and July 2019.

The outfit gives vendors 30 days to address the problem, usually with a software patch, before going public.

27%

Of smartphones have smashed screens.

According to a survey of 2,400 office workers. 2% of those are completely unusable.

KB4515384

Is a Windows 10 update causing some people trouble with connecting to the internet.

If you're affected, try rolling it back.



11Gbit/s

The theoretical maximum combined data rate of a Wi-Fi 6 device.

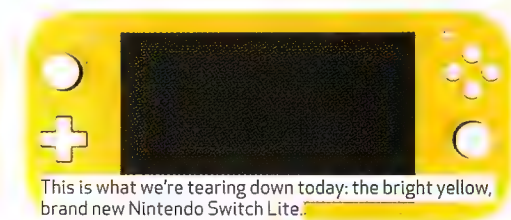
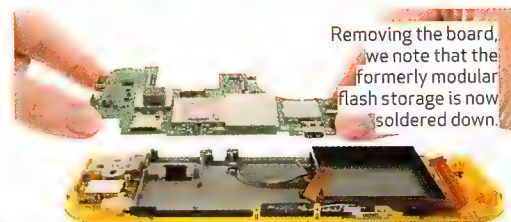
The new wireless standard, aka 802.11ax, is starting to appear on devices now.

60 YEARS

Have passed since the COBOL computer programming language was first designed. Based on work by US rear admiral Grace Hopper, the nearly pensionable language is still widely used on mainframe computers.

THE
MOST FUN
YOU CAN
HAVE WITH
YOUR HANDS
WITHOUT
GOING
KICKING

how it's done



Nintendo Switch Lite

Where the magic happens.

There's a new Switch on the block: the Nintendo Switch Lite, and it comes with less in order to cost you less. It also arrives in some hot new colors.

MAJOR TECH SPECS

- Built-in 5.5-inch 1280×720 capacitive touchscreen LCD
- Custom Nvidia Tegra processor
- 32GB of internal storage (up to 2TB additional storage via microSDHC or microSDXC card)
- 802.11a/b/g/n/ac Wi-Fi, Bluetooth 4.1, NFC, USB Type-C port (charging only), and 3.5 mm audio jack
- Built-in accelerometer and gyroscope
- Rechargeable 13.6Wh lithium-ion battery
- Evolved with undetachable controllers

KEY FINDINGS

- We yanked really hard on the controls in the hope of scoring two new bright yellow Joy-Cons, but alas, they don't detach. A more traditional disassembly is required.
- The way is blocked by impassable tri-point screws. Under the back cover, we find another cover. Moving on, the SD card reader is now permanently attached to the main

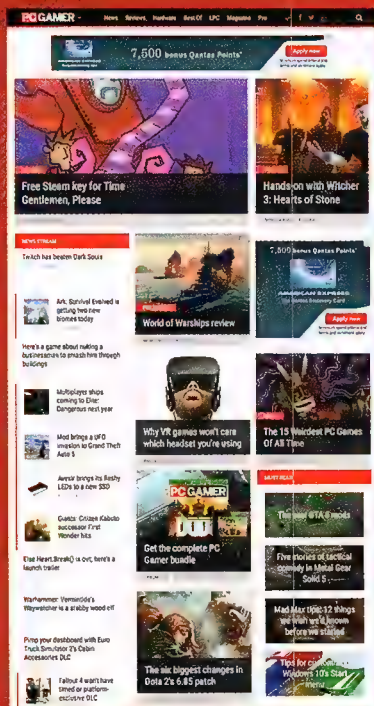
board – on the old Switch, we'd already removed it by now. Modularity is good for repair, so this is a step backward. Let's peek under the metal shield to look at the internals.

- We blow the cover off our revised-for-2019 Switch and do some Lite comparisons. Most important change: The battery in the Lite is no longer upside-down. It's also smaller and sits next to a lighter-gauge heat pipe, while the headphone jack has gone fully modular.
- More efficient hardware makes for longer battery life (three to seven hours, according to Nintendo) and less waste heat, so we're unsurprised to see a downsized heatsink and fan. Another slight difference: The previous L and R triggers pressed directly against a button on a PCB, but the new triggers switch to a membrane-style key.
- Pulling aside a dedicated mini-Joy-Con board, we get to a source of controversy in the Switch – the joystick. Initially, these joysticks look similar to the 2019 Switch joysticks – but the design of the clasps around the edges is different, and the case is easier to open. Inside, there's some new trace routing, a

narrower stick click button, and wider-looking metal sliders. A guess at the cause of joystick drift is that the contact pads under the sliders wear down.

- The original Switch had a non-laminated, air-gapped display, making for cheap and easy screen repairs, so how does the Switch Lite fare? A little heat and prying is all it takes to coax the display assembly from the frame, and with a bit more convincing, the digitiser/screen separates from the display. Success!
- Repairability score: 6 out of 10 (10 is easiest to repair). Screws, rather than adhesives, secure most components. Many components, including joysticks, fan, and headphone jack, are modular and can be replaced independently. The battery, though strongly glued down, can be replaced after removing the rear case. The digitiser and display are not fused, but firmly glued in place. The flash storage and SD card reader are now soldered directly to the motherboard. Uncommon tri-point screws hinder all repairs. ■

SMARTER COOKIES ENABLED

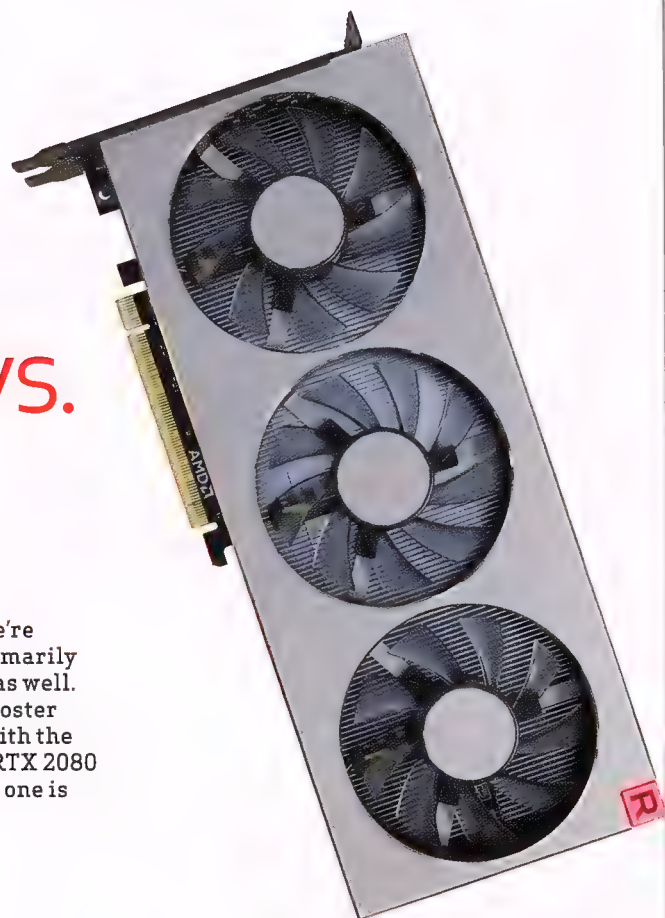


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Radeon VII **vs.** RTX 2080 Super **vs.** RTX 2080 Ti

Which big buck card offers the best bang?

The last hurrah in our series of GPU head to heads, this month we're looking at the high-end cards. We're talking 4K. The focus is primarily on 4K gaming, although other elements are taken into account as well. In the red corner, we have AMD's top offering, the Radeon VII, poster child for the 7nm GPU architecture. Meanwhile, Nvidia sits opposite with the recently released GeForce RTX 2080 Super and the older but stronger RTX 2080 Ti. There are pros and cons to purchasing any of these cards, but which one is the best? Let's dive straight in.



Round 1

VALUE

There's a clear winner in this round: the RTX 2080 Super. That's right, we just spoiled the ending to this round in the first sentence. Hope you've already seen *Endgame*. In all seriousness, though, the 2080 Super is the newest card here, and its status as a price-matched refresh of the original RTX 2080 makes it excellent value. Without costing a cent more, Nvidia improved the performance against the original model by five to ten percent, and the 2080 was no slouch in that area to begin with.

Objectively speaking, none of these cards is particularly good value for money, especially considering that they demand a 4K monitor, too. When examining GPUs on an fps-per-dollar basis, the champions are always cheaper cards, such as the RX 580 and GTX 1660. The Radeon VII might be the cheapest of the three cards we're looking at here, but it only costs 40–70 dollars less than the 2080 Super (depending on the manufacturer) and can't come close to matching its performance. Meanwhile, the 2080 Ti is, unsurprisingly, the most powerful card on show here, but a four-figure price tag can't be justified by 10 extra frames per second when compared to the 2080 Super.

WINNER:
RTX 2080 SUPER

Round 2

EFFICIENCY

The Radeon VII is, unfortunately, quite a poor card when it comes to efficiency, being the first 7nm GPU available commercially – the kinks with 7nm still haven't quite been ironed out. It does have a relatively high temperature limit (it won't force a shutdown until it hits a whopping 120°C), and it performs fairly well undervolted, but that comes with a comparable drop in performance. The base power draw is a crippling 300W; unsurprising given this card's ridiculous amount of VRAM and crazy-fast memory speed – more on that later.

The 2080 Ti is a demanding card, but it comes with the same TDP as the 2080 Super: 250W. The Super card clocks higher, but the Ti packs more VRAM, better bandwidth, more transistors, more CUDA cores... It simply has superior architecture. The Turing TU104 architecture used by the RTX 2080 evolved to its perfect form in the Super GPU, but the 2080 Ti's TU102 design is just more advanced. While practical power use and noise are variable with any GPU (particularly if you're overclocking), the same base power draw for your system means that the 2080 Ti is – perhaps surprisingly – the most efficient card of the three.

WINNER:
RTX 2080 Ti

Round 3

OVERCLOCKING

Taking a look at the base and boost clocks available for these cards, the RTX 2080 Ti is very much starting to show its age. The reported boost clock on the Founder's Edition is a mere 1,635MHz, lower than the 2080 Super's base clock of 1,650MHz. The 2080 Ti has pretty good headroom for manual overclocking, but the speed still isn't going to get as high as the Super, which can comfortably eke out an additional five to ten percent of memory speed in typical overclocking.

The Radeon VII is a bit of a slouch here. While the boost clock of 1,750MHz is respectable, squeezing more than five percent of improved performance from this card is a struggle. The high temperature limits on this card do help a bit, but unfortunately the limits of the current 7nm FinFET architecture are plain to see. The 2080 Super is easily capable of breaching 2,000MHz when overclocked, which can partially make up for the lower baseline performance when compared to the 2080 Ti. It's not going to reach the same heights as the more expensive card, but it's got just as much headroom for manual overclocking, if not more, and also has a greater improvement between base and boost clocks: an increase of 165MHz as opposed to the 2080 Ti's 120MHz.

WINNER:
RTX 2080 SUPER



Round 4

PERFORMANCE

Watch out, here comes another spoiler – though we hope you saw this one coming. The RTX 2080 Ti obliterates the other cards when it comes to performance, arguably the most viable option for 4K ultra gaming right now. The other cards effectively demand a sacrifice of either frame rate or graphical fidelity when running games at 4K – even the Ti struggles with some games, though. The 2080 Super does its level best to keep up, and performs admirably considering it costs more than a third less than its older brother. It's also worth noting that both are equipped with ray-tracing tech, which the AMD card lacks; indeed, the 2080 Ti and 2080 Super are practically the only

GPUs suitable for ray tracing at high graphical levels right now.

Sadly, the Radeon VII falls behind. While many hoped it would be a GeForce-killer, no ray tracing and lackluster frame rates killed that dream. However, it's worth noting that the VII excels in other areas: 16GB of VRAM, 2GT/s of memory speed, and a stonking terabyte/s of memory bandwidth mean it's a powerhouse when it comes to 3D rendering and video editing. We're looking at 4K gaming here, but it's a solid workhorse GPU that doesn't bite your wallet as badly as Nvidia's high-end cards, such as the Quadro and the Tesla.

	RTX 2080 SUPER	RTX 2080 TI	RADEON VII
TOM CLANCY'S THE DIVISION 2 (FPS)	47/40	59/50	39/33
ASSASSIN'S CREED ODYSSEY (FPS)	43/35	53/40	37/27
FAR CRY 5 (FPS)	62/53	78/64	58/46
SHADOW OF THE TOMB RAIDER (FPS)	52/43	62/50	46/35
MIDDLE EARTH: SHADOW OF WAR (FPS)	57/44	72/56	49/38
METRO EXODUS (FPS)	46/30	57/37	42/27
TOTAL WAR: WARHAMMER II (FPS)	59/47	72/57	43/32

Best scores are in bold. Our test bed consists of an Intel Core i7-8700K, 16GB of G.Skill DDR4-3200, a Gigabyte Z370 Aorus Gaming 7, and a 1TB Samsung 970 Evo M.2. All games are tested at their highest graphical profile with AA turned on at 4K. Figures provided are an average and a minimum (97th percentile) respectively.

WINNER:
RTX 2080 TI

And the winner is...

The Radeon VII! No, just kidding, although we don't want to discredit AMD's top-tier GPU, particularly if you use your system primarily for content creation. The real winner is the GeForce RTX 2080 Super. It was a close call, but we've got to give it to the newer card; it's simply better value, and provides sufficient performance to hold its ground at 4K without breaking the bank. Ray tracing and the improved TU104 architecture only sweeten the deal.

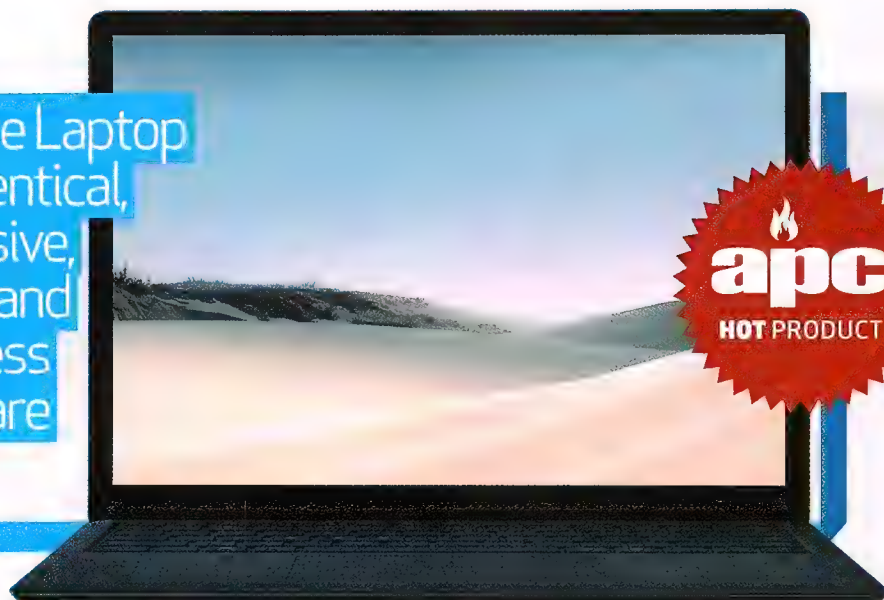
When it comes down to it, the main reason to buy an RTX 2080 Ti is because it's the best commercially available GPU around. If you've got an urgent need to have the absolute best of the best, sure, it's a great card. But twin-fan models of the 2080 Super are available for scarcely more than \$1,100, and it'll run most games at a respectable frame rate in 4K – more so if you're willing to drop from ultra to high settings. For \$500 dollars less, it's hard not to admit that the Super is just that: a super alternative to pricier 4K options.

And lastly, yes, we're aware that the Titan RTX exists. Despite ostensibly being the best gaming GPU on the market, it would lose every category except performance, and the insane price tag means we'd never recommend it for mere 4K gaming. Please don't come after us on Twitter for doling out some hard truths.

"Both the Surface Laptop 3s come with identical, soft and responsive, glass trackpads and square ten-keyless keyboards that are easy to use."

LAPTOP

FROM \$1,699 | MICROSOFT.COM



Microsoft Surface Laptop 3 13-inch & 15-inch

Microsoft has pitched AMD and Intel in a laptop battle royale by powering each new Surface Laptop 3 with competing CPUs. So which one comes out on top in this defining battle for laptop supremacy?

With AMD dominating the desktop CPU space this year, Microsoft has given it the opportunity to compete against Intel in the new Surface Laptop 3s. AMD was given the task of designing a custom CPU for the 15-inch Surface Laptop 3, while Intel was delegated the task of driving the less expensive 13-inch clamshell. Generally, laptop makers give the bigger units more grunt for creative professionals, while the smaller devices appeal to those looking for something that's better value and more portable – but because these units have competing chip makers driving them, they're actually very different laptops that try to achieve different things.

Before we dig into the differences, these are both

Surface Laptop 3s, so there are a lot of consistencies across the units. Both the 13-inch and 15-inch models offer a Black all-metal chassis or a Platinum metal clamshell with the iconic Alcantara keyboard surround a returning feature of the Surface Laptop 2. The 13-inch laptop actually offers additional Sandstone metal and Cobalt Blue Alcantara colourations for those that want to be a little more adventurous with colouring.

GETTING THE BASICS RIGHT

Both the Surface Laptop 3s come with identical, soft and responsive, glass trackpads and square ten-keyless keyboards that are easy to use. This combined with the device's USB 3 Type-A, USB 3.1

Type-C, 3.5mm headphone jack and Surface Connect ports make it really versatile against some competitors – since you don't need an additional dock. While there's no fingerprint reader, Windows Hello Face is quick and secure enough to make for an easy sign in process.

If you look at the general display specs, both the monitors share the same 10-point multitouch PixelSense Touchscreen display in a 3x2 aspect ratio with a 201 Pixel Per Inch resolution. The smaller model has a 13.5-inch screen and an unusual 2256 x 1504 pixel resolution while the 15-inch version's resolution is slightly higher at 2496 x 1664 pixels. This is definitely the sweet spot for laptop displays since it offers greater clarity for

documents without taking the battery hit that you get by going full 4K. The screens look vibrant with an average brightness around the 400 nit mark, and while you do get access to Windows 10's HDR video streaming options in both variants, the screens can only reproduce around 63.4% of the Adobe RGB colour profile – so it's not ideal for creatives or HDR playback.

BIG OLE BAG OF CHIPS

On the surface these two devices are identical in many ways, but because of the use of two distinct CPU architectures they are actually very different. Both the 13-inch and 15-inch Surface Laptop 3 devices can be configured with a choice of two processors from their



"Both the 13-inch and 15-inch Surface Laptop 3 devices can be configured with a choice of two processors from their respective manufacturers."

respective manufacturers. So, the 13-inch Surface Laptop comes with either a (1.2 to 3.7GHz) Intel Core i5 1035G7 or a (1.3 to 3.9GHz) Intel Core i7 1065G7 CPU, which are both part of Intel's recently announced 10th generation processor range and so come with the new Wi-Fi 6 support and faster Thunderbolt 3 connectivity.

The 15-incher on the other hand, can be configured with either a (2.1 to 3.7GHz) AMD Ryzen 5 3580U or a (2.3 to 4GHz) AMD Ryzen 7 3780U CPU, chips that were launched alongside the Surface

Laptop 3 in October 2019. These new AMD processors have four cores and eight threads like their blue-blooded competition, but they miss out on the Wi-Fi 6, offering instead FreeSync capability (which isn't all that useful on these moderately powered non-gaming PCs).

The Intel-based Surface Laptop 3 can be configured with either of the Intel chips mentioned above, 8 or 16GB of RAM, and between 256GB and 1TB of onboard storage, and costs between \$1,699 and \$3,949, depending on what you opt for. AMD's Ryzen 5 or Ryzen 7 Surface

laptop variants start at \$1,999 for the Ryzen 5 CPU, 8GB of RAM and 128GB of storage, while the Ryzen 7, 32GB RAM and 1TB storage version comes in at \$4,399. With such a broad overlap in configurations the Surface Laptop 3 is a great experiment.

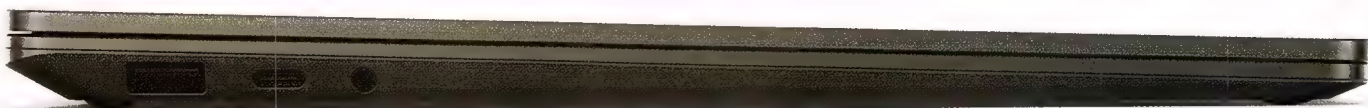
PUTTING THEM TO WORK

We tested the Surface Laptop 3 13 with the Core i5 CPU, 8GB of RAM, and a 256GB PCIe SSD that retails for \$1,999 and a Surface Laptop 3 15 with a Ryzen 5 CPU, 16GB of RAM, and a 256GB PCIe SSD that costs \$2,799. While the latter has

double the RAM allocation and a 1.5-inch bigger screen, it's \$800 more expensive, when those two factors really only account for about \$500 of the price bump, so AMD is already on the back foot in terms of value.

When you actually pit these two processors against each other in performance benchmarks, the 13.5-inch Intel i5 model beat the 15-inch AMD Ryzen 5 version on almost every single parameter. For PCMark 8 and PCMark 10 benchmarks the difference was less than 10%, but for HWBot x265's CPU heavy media encoding benchmarks, the Ryzen 5 had between 15 and 25% lower frame rates than the Intel Surface Laptop 3 13.

A lot of this can be explained by the temperatures that the processors are operating at. Since the 15-inch AMD



"While both the new Surface Laptop 3s show between 15% and 30% CPU performance boosts over the Surface Laptop 2 Intel Core i5, 3D Mark graphical tests showed improvements of up to 112%."



device didn't peak above 78 degrees in any benchmark, while the Intel 13 incher regularly spiked all the way up to 100 degrees (and potentially beyond since the sensors stop reading at this point). Intel has undoubtedly done some work in overclocking the Surface Laptop 3's chips for maximum performance, a response we assume was prompted by the new AMD competition. Normally we would also conclude that AMD didn't do much to optimise these chips, but the one parameter the Surface Laptop 3 15s outperform their smaller siblings is in battery life, and the lower operating temperature is likely to be part of the explanation for that.

POWER AND PERFORMANCE

Both CPUs run, on an average, at 15W and have roughly a 46Wh battery capacity. They also have screens that are pretty close in total pixel count so, all things considered they should have comparable battery lifespans. However, in PCMark 8 Home Battery the Surface Laptop 13 gets 4 hours and 37 minutes, while the Surface Laptop 15 ran for a total of 9 hours and 40 minutes on a single charge. When it came to 1080p movie playback the difference wasn't quite as drastic, but the Surface Laptop 15 still lasted 19% longer than the 13 inch model, with a total of 5 hours and 56 minutes. This

is a considerable difference for two devices with similar performance and goes a long way to justify the performance loss you see in processing tasks on the AMD 15-inch Surface 3.

While both the new Surface Laptop 3s show between 15% and 30% CPU performance boosts over the Surface Laptop 2 Intel Core i5, 3D Mark graphical tests showed improvements of up to 112%. The new Intel Iris Plus Graphics and the AMD Radeon Vega 9 Graphics are still a long way off being gaming-grade GPUs, but we were able to get more than double the framerates on light games like *Rocket League*. We had a few glitches with the new Intel GPU and some 3D Mark benchmarks and while the

AMD Surface Laptop 3 got 85fps averages on *Rocket League* in 1080p performance mode, the Intel Surface Laptop 3 got just 55fps. Both show improvement on the Surface Laptop 2's 40fps average using the same settings but if you want a little extra gaming performance then the AMD unit takes the cake at the moment. ■ Joel Burgess

Verdict

If you want a better value and a more compact laptop go with Intel's 13-incher, but for those wanting all-day battery life the 15-inch AMD Surface 3 is the key.



MICROSOFT SURFACE LAPTOP 3 13-INCH & 15-INCH BENCHMARKS

	MICROSOFT SURFACE LAPTOP 3 13	MICROSOFT SURFACE LAPTOP 3 15	MICROSOFT SURFACE LAPTOP 2	MICROSOFT SURFACE LAPTOP
PCMARK 8 - HOME (SCORE)	3299	3276	2703	3463
CINEBENCH R15 - CPU (MULTI-THREADED)	678	673	581	326
3DMARK TIME SPY (SCORE)	861	899	443	373
PCMARK 8 - BATTERY (H:MIN)	04:37	09:40	06:07	04:48
BATTERY LIFE - 1080P VIDEO PLAYBACK (H:MIN)	04:48	05:56	08:08	08:48
PEAK CPU TEMPERATURE (°C)	100	78	73	73
CRYSTALDISKMARK READ/WRITE (MB/S)	2327/1587	2021.7/823	1643.8/811.7	647.5/234.2



LAPTOP

\$1,299 | WWW.ASIS.COM/AU

Asus Zenbook Flip 13

Three hundred and sixty degrees of cool.

There's something rather enticing about the Zenbook Flip 13, but we can't quite put our finger on it. Convertible laptops can be hit and miss, but the latest in Asus's Zenbook line feels as though it might have struck gold. Lightweight but not flimsy, silent but not underpowered, this is the ideal on-the-go tablet or at-home work laptop, but at just under \$1,300, it's not exactly the most affordable notebook in the business.

You get a lot for your money, though. Our model comes with an Intel Core i5-8265U – a more powerful i7 version is also available – along with 8GB of RAM, a 256GB PCIe SSD, and integrated Intel UHD Graphics 620. It's whisper-silent, thanks to passive cooling, and has a smaller footprint compared to its predecessor, with a tiny bezel around the screen. The 360-degree hinge is rated for 20,000 cycles.

The metallic blue finish looks great, and on inspection, is quite resistant to light damage.

The same can't be said of the touchscreen, which, like many two-in-one notebooks, was frustratingly covered in fingerprints after just a brief period of use. Be prepared to either shell out for a compatible stylus or carry a microfiber cloth around. Yes, this half-tablet doesn't come with a stylus or smart pen, which feels slightly like a missed opportunity, but is by no means a deal-breaker for most users. For on-the-go artistic types, though, it could be a drawback. Asus does sell its own smart pen, which by all accounts is a good tool for digital art.

The 1080p display looks brilliant, providing vibrant color and glare reduction, which comes in handy when working in a brightly-lit or outdoor environment. The 90 percent screen-to-body ratio is a great improvement on older Zenbooks, and the screen is viewable from wide angles without color or image distortion – perfect for watching movies in the tent orientation. This does raise some privacy concerns,

however; with such a wide viewing angle, it's all too easy for prying eyes to spy your work in a public space.

Staying with the notion of privacy, the Flip 13 has two cameras: one in the usual above-screen orientation for standard webcam purposes, and a second one to the left of the keyboard, facing directly up. It's an odd design choice, but it effectively works as an external rear camera when the notebook is in tablet mode. The downside is that neither camera has a cover or dedicated kill switch, features that have become increasingly popular in modern notebooks.

With regard to the external hardware, the keyboard feels comfortable and responsive, with white backlighting and a satisfying amount of key travel. The trackpad functions well and conceals a nifty new feature: With the click of a button, a hidden numpad illuminates beneath the trackpad. Not everyone will use it, but it's handy for anyone who works

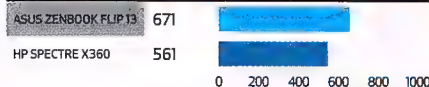
with numbers (and is a nice little feature to show off on your cool new notebook).

There's not much else to say; this is a solid convertible notebook that performs reasonably well. The brilliant audio – courtesy of sound master Harman Kardon – only serves to sweeten the deal. One disappointment lies in the lack of an M.2 SSD, but many users won't notice much of a difference; the relatively small 256GB storage capacity means that shuffling massive files around isn't really a possibility anyway. This notebook isn't without its drawbacks, but for a busy professional on the move, it gets the job done well. ■

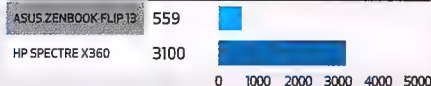
Christian Guyton

LABS BENCHMARK RESULTS

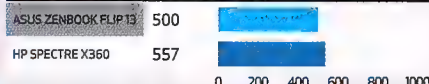
CINEBENCH R15 MULTI (INDEX)



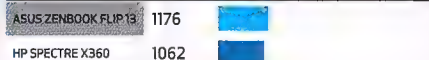
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)



CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)



3DMARK: FIRE STRIKE (INDEX)



Verdict

Resilient design; bright screen; high-quality audio. Little in the way of privacy features; SATA-speed SSD.





DESKTOP

\$7,049 | WWW.ACER.COM

Acer ConceptD 500

Acer enters the fray with new designer hardware.

Acer has zeroed in on a key problem with the computer hardware market: Content creators are experiencing a dearth of purpose-built systems, instead opting to buy powerful gaming PCs for their 4K video-editing needs. That wouldn't necessarily be a problem, if it weren't for the fact that many working professionals don't want a giant, glowing RGB unit shooting red and blue lighting all over the place.

So, the ConceptD 500. The standard desktop model in the ConceptD range (which includes laptops, monitors, and more) is a high-powered system, meant to integrate seamlessly and unobtrusively into office spaces with a simple, aesthetically pleasing design. Convenience is a cornerstone of this system's design; the faux-wood finish on top includes a Qi wireless charging pad hidden beneath, enabling you to drop your phone atop the case for a battery boost. At the front, a quick press reveals a spring-loaded

mount to hang a pair of headphones on. The top I/O is covered with an odd plastic shield that can be removed to access it; we get the impression that it would be tossed aside immediately by 95 percent of users, but that's fine.

As Acer describes it, the ConceptD 500 is "elegantly honest." There are no hidden bells and whistles here, just high-quality components inside a minimalist case. When powered on, the gray plastic ring surrounding the wooden top panel emits a (slightly feeble) orange glow. At the rear, two silver clips at the top and bottom of the panel allow for some cable management. It's also impressively quiet; the front panel appears solid at first glance, but subtle gaps in the triangular design allow for air to be drawn in by the case fans, although said fans are pretty tiny.

Of course, it's all about the hardware inside. A Core i9-9900K processor powers this system, backed up by a mighty 64GB of DDR4-2666 memory, prepped and ready

for complex design work. Graphics are handled by a RTX Quadro 4000 GPU, ideal for everything from 3D architectural rendering to driving high-fidelity environments in VR, and as the name implies, we've got full ray-tracing support, too. The OS boots from a high-speed M.2 drive, which also ensures that any programs load rapidly. Two more HDDs provide an additional 4TB of storage for videos, images, and more, with models packing both 2.5-inch and 3.5-inch drives.

The system also comes with a handful of slightly unusual but still beneficial features. Pre-loaded on to the desktop is ConceptD Palette, a simple system-monitoring tool that lets you check the usage of your CPU, GPU, and memory at a glance. There's also a system health indicator LED on the top I/O, which pings should something untoward occur. Lastly, there's an intrusion alarm. This triggers a notification on boot next time the system powers up, should the case be opened -

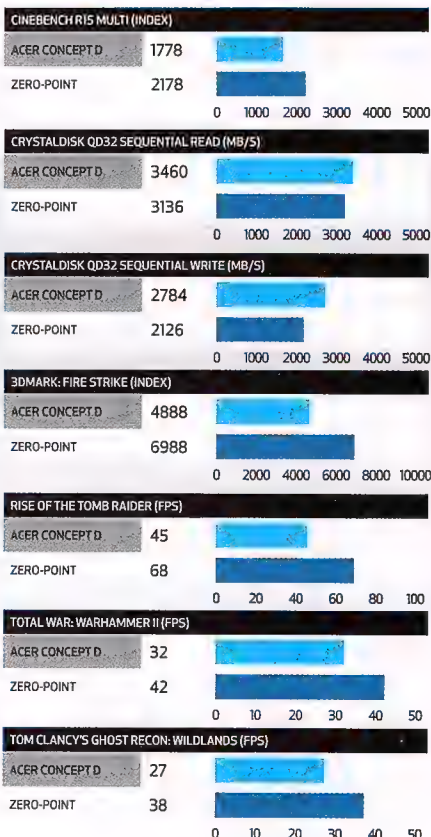
a tamper alert, essentially.

While this is a competent platform for 4K gaming, that's not what it was designed for; instead, it excels at rendering, video editing, and 3D art. Versatile, it's at home in the office space of a graphic design business or the home office of an architect. Cracking open the case doesn't show anything appealing, just a mess of cables and unbranded silicon, but the target audience isn't likely to want to make modifications. If you're looking for a workstation PC to support your tech startup or 3D animation firm, this is the machine for you. ■

Christian Guyton

Our zero-point consists of an Intel Core i9-7900X, 32GB G.Skill RipJaws V series DDR4 @ 3,000, an MSI GeForce GTX 1080 Ti Gaming X, and a 512GB Samsung 960 Pro PCIe SSD. All tests performed at 4K at the highest graphical profile.

LABS BENCHMARK RESULTS



Verdict

Powerful hardware; charming visual design; purpose-built for creatives. A little pricey though.





MONITOR

\$3,699 | WWW.ASUS.COM/AU/

Asus ROG Swift PG35VQ

A gaming monitor to rule them all. But does it?

Last year Nvidia and its partners introduced us to an exorbitantly-priced monitor based on a technology concept called G-Sync HDR which offered dynamic High Dynamic Range adjustment (like TV's Dolby Vision), but for games. It was maddening to get working but the technology has matured to the point where Asus ROG Swift PG35VQ now exists. Why does this matter? Because, in theory, it should be the best gaming monitor ever made.

The clunky original felt like an axe-hewn screen stuck onto one of Asus' fancy stands. The PH35VQ, however, is much more refined: resplendent with full ROG detailing and programmable Aura RGB lighting at both the base and back. G-Sync HDR has since been re-branded, G-Sync Ultimate but the fundamentals are the same: maintaining colour accuracy and uniform image quality while simultaneously adjusting both framerates and HDR involves some seriously

complex processing.

But first, some of the specs: it sports a blinding 1,000-nit (peak) brightness, super-speedy 200Hz (overdriven) refresh rate, 90 per cent support of the top-rated, cinema-specified DCI-P3 colour gamut, 512-zone rear-LED-array dimming and a curved, ultra-wide (21:9) VA-technology screen with a 3,440 x 1,440 resolution.

The OSD is fast and intuitive to use, there are gaming features such as a crosshair overlay and FPS counter plus blue-light filters and the usual set of pre-sets like Cinema, FPS (which adjusts contrast to help see enemies better) etcetera. Connectivity includes DisplayPort 1.4, HDMI 2.0, USB 3.0 and 3.5mm headphone jack. But what's it like to actually use?

When playing HDR-compatible games you'll quickly notice the extra vibrancy. Bright light seemingly glows out of the screen in games like *Call of Duty: Modern Warfare* and

yet doesn't make targets harder to see – although you can be distracted when admiring the scenery. *Far Cry 5*'s stunningly-lit wilderness looks sublime. Meanwhile, in less-optimised games like *Metro Exodus*, detail remains visible in very bright areas and very dark areas simultaneously which is something that lesser monitors are unable to achieve. Ultimately, games can look phenomenal although competitive gamers will likely turn off the graphical enhancements to minimise distractions.

However, there are some issues. Firstly, the 200Hz overdrive is only available with SDR. Otherwise you're limited to 100Hz. While dynamic framerate adjustment helps smooth things out, competitive gamers will likely want more. Secondly, there is noticeable halo-effect blooming around bright areas on dark backgrounds which you'll easily see when moving a mouse cursor across a black screen.

Thirdly, having become used to superb cinematic reproduction on large-screen TVs, it was disappointing to see messy compression artefacts and banding in colour gradients on UHD video. Another annoyance was the active fan – the lighting array needs cooling and, though quiet, we could hear it gently whirring away in the background. Nonetheless, a crisp and clear Windows desktop is produced and working on the wide display was a joy.

So, who should buy this \$3,699 beast that costs more than a 50-inch OLED TV? If money is no issue and you demand your games to look the best, it's for you. Otherwise it's an overpriced luxury. ■ Nick Ross

Verdict

Superb at displaying beautiful gaming imagery but less-than-perfect for everything else: an expensive luxury.





CPU

#899 | WWW.INTEL.COM.AU

Intel Core i9-9900KS

Wringing the neck of 14nm.

Throughout 2019, most of the salvos in the ever continuing CPU war have been fired by AMD. While Intel has held its own under lightly threaded workloads, it's been falling behind under loads that can make use of a high number of cores. The Core i9-9900KS is Intel's attempt at rebalancing its flagship's performance. It does this by combining its well documented single threaded performance with a rather stunning 5GHz sustainable all core boost. From what we know of the identical 9900K when it's overclocked, we know the 9900KS will be fast, but is it enough to win hearts and minds?

The 9900KS is simply a higher binned and overclocked 9900K. It comes with a base clock of 4.0GHz, up from the 3.6GHz of the 9900K. The headline feature is its 5.0GHz all core boost. The 9900K can also boost to 5.0GHz, but only to 4.7GHz

with all of its cores loaded. The KS is also a limited edition. With Comet Lake on the horizon, don't expect the KS to be around for very long. Also note that it carries a one year warranty vs the normal three years for Intel processors. That's definitely a step backwards.

Gaming performance is where the 9900KS shines. If you're looking to extract every possible frame from your game, the 9900KS is the CPU to buy, hands down. If you're using a very high refresh rate monitor, or gaming competitively, then there's no better choice.

When it comes to multithreading, the cheaper AMD 3900X is the clear winner with its 12 cores and cheaper price. Things aren't rosy when it comes to loaded power consumption either. Our test sample recorded a 292w total system power draw when loaded compared to 272w for the 9900K and just 204w for a 3900X

system. This indicates Intel has had to really push the voltage to reach the golden 5GHz number. Heat is also a concern, with our sample reaching well into the 80s with a very capable Thermalright Water 3.0 360mm AIO cooler. If you plan to overclock the 9900KS, be prepared to invest in a top end AIO cooler, or even better a custom loop.

The way things are, Intel is in a tough competitive spot. It's clear that it needs to fix its 10nm woes as soon as possible. It's simply not feasible to ship competitive 12, 14 or 16 core mainstream CPUs without resorting to very large, hot and power hungry dies. Intel is reportedly due to ship a 14nm 10-core model sometime next year, but its competing with AMD's 7nm 12- and 16-core models, and that's without considering its refreshed Zen 3 line up due in 2020.

The 9900KS does what is supposed to. It keeps Intel competitive with regards to multi-threading performance and it holds the crown as the best gaming processor to buy right now. The competition is relentless though. Intel desperately needs a new architecture, process, and it could use some features like PCIe 4.0 and/or more PCIe lanes if it is to truly win across the board in 2020. ■

Chris Szweczyk

LABS BENCHMARK RESULTS

3DMARK TIMESPY (SCORE)

INTEL CORE I7-8700K	12,656
INTEL CORE I9-9900K	13,560
INTEL CORE I9-9900KS	13,687
AMD RYZEN 9 3900X	13,738

GHOST RECON: WILDLANDS (1080P, LOW, AVG FPS)

INTEL CORE I7-8700K	196
INTEL CORE I9-9900K	204
INTEL CORE I9-9900KS	211
AMD RYZEN 9 3900X	193

Verdict

Enthusiast gamers will love the 9900KS but Intel needs something truly new to remain competitive in 2020.





MOTHERBOARD

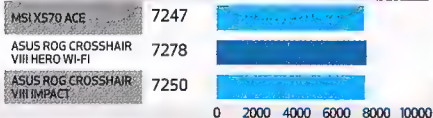
\$729 | WWW.ASUS.COM.AU

LABS BENCHMARK RESULTS

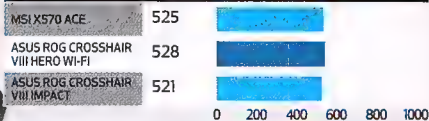
CINEGY CINESCORE VIDEO ENCODING - AVC 400 ULTRA 2160P FPS



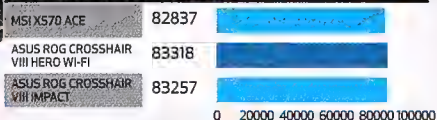
CINEBENCH R20 - MULTI-THREAD SCORE



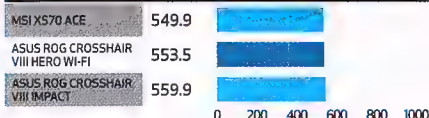
CINEBENCH R20 - SINGLE THREAD SCORE



7ZIP - MILLION INSTRUCTION PER SECOND



CPUZ - SINGLE THREADED SCORE



Asus Crosshair VIII Impact

A little board that makes a big impact.

We're very happy to see the return of the small form factor Impact to Asus' line up, having been absent from the last couple of generations. Impact boards always seemed like a labour of love for Asus engineers, with their one-off daughter boards and unique implementations. The X570 equipped Crosshair VIII Impact (C8I) looks like it does justice to the Impact legacy.

One obvious area of departure for the C8I is its form factor. Whereas Impact boards have previously been true mini-ITX designs, the Crosshair VIII Impact is instead a mini-DTX board, where the PCB is about 3cm longer at the bottom part of the motherboard. While a mini-DTX board won't fit in a true ITX case, most of them do allow for a dual slot graphics card so it should be widely compatible.

There are a few notable features. The backplate features an attached heatpipe to help cool the VRM. You'll also notice a version of Asus' DIMM.2 m.2 drive storage technology,

shrunk down to the SO-DIMM form factor. While you're not getting memory speeds as some might think, it's an interesting way to mount the drives, and no doubt represents a significant engineering investment to make it work properly.

You get all the standard features you'd expect on an X570 motherboard, though at this price we'd like to see 2.5G LAN or better. A top quality power delivery system capable of powering the 3950X, along with Wi-Fi 6 and a quality audio implementation are welcome, though they're standard at this price. Note that the board doesn't have any video outputs and only three analogue audio jacks if you're planning to use it with a surround sound speaker set.

One of the areas the Impact excelled in our testing was memory overclocking, in part thanks to its two DIMM design. These days, testing CPU OC is almost pointless on high end motherboards as current generation CPUs run into cooling limitations before the motherboard breaks a sweat. Not all boards are created equal when it comes to memory support though. If you have a good set of B-Die memory, you'll be very pleased with the abilities of the C8I. Do check out the memory OC profiles in the BIOS.

Summing up a board like this is difficult. There's no doubt it's innovative, but we struggle to define exactly what its purpose is. At \$729 its pricing is far too high. For most users, the toughest competition for the Impact

comes from Asus' own Strix X570i. It's an ITX design, costs 40% less and has a mostly similar feature set. We think the Impact is best suited to overclockers, particularly those running very fast memory and high core count CPUs.

We love the way Asus is never afraid to push the envelope and innovate. The C8I is fast, very capable it and loves high speed memory. What it really needs is a hundred or two knocked off the price and we'd be all over it. ■ Chris Szweczyk

Verdict

An innovative and overclocker friendly mini motherboard that's let down by its exorbitant price.



apc
RECOMMENDS



MOTHERBOARD

\$799 | WWW.ASROCK.COM

Asrock X299 Taichi CLX

Maintaining Asrock's balancing act of value and performance.

When we look at a platform like Intel's X299, and AMD's Threadripper too, for that matter, we often wonder why motherboard manufacturers excessively focus on gaming when the mainstream platforms are better options. Asrock's Taichi brand doesn't resort to this tactic, usually delivering an excellent combination of useful features and affordable price. X299 refresh motherboards have undoubtedly taken a step up in price though, and at \$799 the X299 Taichi CLX can't be considered an affordable board any longer. With this in mind, can the latest Taichi land in the sweet spot as we've come to expect from Asrock?

The X299 Taichi CLX looks every bit a high end board and you'd expect it to have a long list of features. While it's not a barebones motherboard by any measure, it doesn't come

with all the bells and whistles that are found on the disappointingly high number of X299 boards that approach and exceed the \$1,000 mark. The overall design with its artistic gears and cogs is a nice touch. Of course you still get a touch of RGB around the board, but it's not blinding by any means. The VRM system of the board is strong with 13 phases and twin eight-pin EPS power connectors. We'd like to see the heatsink have some more surface area, but that's nit-picking really.

Other key features include an impressive ten SATA ports, triple M.2 slots and 2.5 Gigabit LAN. The Realtek RTL8125AG 2.5G controller is a very welcome addition to the market. On the topic of networking, the Taichi CLX includes Intel's latest Wi-Fi 6 controller along with Bluetooth 5.0.

The rear I/O is fairly standard with 6x USB ports

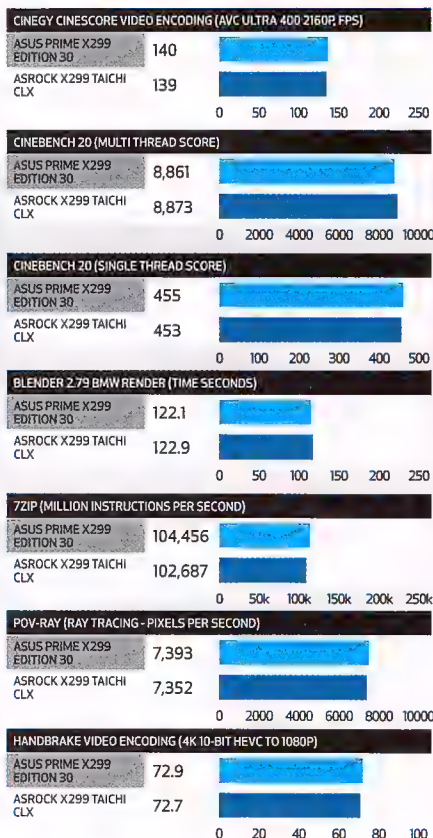
plus an additional Type-C. There's no Thunderbolt 3 or unique gadgets present, though it seems those are the things that differentiate an \$800 board from one that costs 50% more.

When it comes to performance, the Asrock tended to trail the more expensive Asus Prime Edition 30 more often than not. While in the grand scheme of things, 1 or 2% here or there won't be noticed, it's better to be in front than not. It's still amazing to see just how the high-core-count processors from Intel and AMD simply destroy benchmarks that can make use of all those cores, even though game engines and Windows thread allocations can still present issues.

Asrock's Taichi brand continues to offer a sweet spot combination of features, refinement and to a lesser extent this time

around, pricing. The X299 Taichi CLX looks great, it has an easy to navigate BIOS and makes a big generational step up in terms of networking. You won't be lacking storage options either. We're sad to see pricing is really going upwards though. If Cascade Lake-X is on your shopping list (we'll have a full review in our next issue), the Taichi CLX may actually end up being one of the more affordable X299 refresh options if you can believe that. It's a good solid board and brings a welcome feature update to the X299 platform. ■ Chris Szewczyk

LABS BENCHMARK RESULTS



Verdict

The Asrock Taichi CLX is a good board, though we're sad to see a distinct uptick in HEDT motherboard pricing.



apc
HOT PRODUCT



MOTHERBOARD

\$1,149 | WWW.ASUS.COM.AU

Asus Prime X299 Edition 30

A stunningly premium motherboard with a price to match.

When I first took the Asus Prime X299 Edition 30 out of the box, I fell in love. It's one of the most attractive motherboard designs (and packages) I've ever seen. Though admittedly looks are not at the top of the list when evaluating a high end motherboard, it just oozes appeal with its subtle modern finish and the way the gorgeous OLED panel looks when the system is powered up. It screams "I am premium" and if the looks don't do that, then the price tag will. At \$1,149 the Edition 30 is one of the most expensive consumer motherboards on the market. Is it worth the price?

The Asus Prime X299 Edition 30 comes with pretty much every connectivity and expansion feature that a 2019 era motherboard could want. Rather than rattle off endless specs, we'll concentrate on a few of the

key differentiating features the board has. There's a two-inch OLED screen in the centre of the board that can display information such as clock speeds, temperatures, voltages or even custom animated GIFs. It looks gorgeous. You get a fan extension card which adds a further six adjustable headers as well as three addressable RGB headers.

The Edition 30 comes with an external USB 'Smart Control Console'. It has an OLED display with similar functionality to the one mounted on the board itself. It's also an IR webcam that supports face recognition, gesture control and even has Alexa and Cortana voice recognition support. It will be interesting to see if this kind of control functionality catches on in the wider market.

As with most of the other X299 refresh boards, the Edition 30 has a truly high-end power delivery

system that Asus claims is capable of delivering 544W of power. The heatsink assembly includes an embedded fan that switches on only when the VRM goes over 60°. It's nice to see a genuine finned heatsink design that prioritises functionality as well as aesthetics.

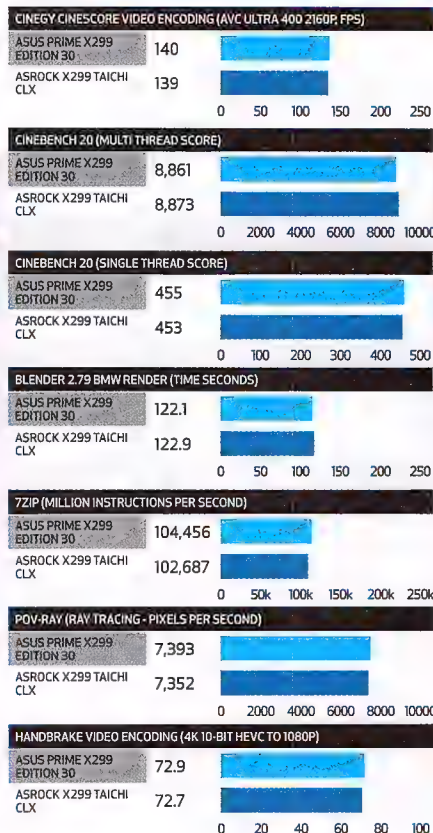
The Edition 30 really demonstrates the power of a CPU like the i9-9980XE. While AMD's Threadripper processors rule the roost with regards to outright multi-threading performance, the 9980XE's single threaded prowess makes it a balanced all-rounder, though that may well change when we see 3rd generation Threadripper can do. Competition aside, a board like the Prime Edition 30 brings out the best of Intel's HEDT lineup.

The Prime X299 Edition 30 is premium in every way. There is simply no better X299 motherboard on the

market, but at this end of the market, you have to pay to play. When it comes down to it, \$1,149 is a lot to pay for a motherboard. At least here you're paying for a level of refinement that cannot be beaten.

Is it overkill? Probably, but if you're a professional or an enthusiast with deep pockets, and can make use of the strengths of the platform and need a lot of multi-threaded power, then the Prime X299 Edition 30 is one of the finest motherboards on the market, but boy does it come at a cost. ■ Chris Szewczyk

LABS BENCHMARK RESULTS



Verdict

A premium motherboard if ever there was one, but you don't get this kind of functionality for cheap.



"Impressively, the EXO almost scored top SpeedTest scores at all levels – only dropping when two floors up, by 10Mbps."



apc
HOT PRODUCT

WI-FI ROUTER

\$379 | WWW.DLINK.COM.AU

D-Link EXO DIR-3060

D-Link's latest implementation of McAfee's Secure Home Platform slashes the price and ramps-up performance.

A few months ago we tested a collaboration with Intel and McAfee that saw a D-Link router running McAfee's Secure Home Platform on Intel System-On-Chip hardware. The resulting rice-cooker-looking D-Fend DIR-2680 offered decent performance, good network and client security but only three ethernet ports and a whopping \$500 price tag. Purchasers of that might feel put-out to see the DIR-3060, which offers similar security and pipped-up performance for just \$379.

It's a little disappointing to see AC-based tri-band Wi-Fi rather than the all-conquering Wi-Fi 6 but the promises of potential 3,000Mbps speeds partly allay any fears. Nonetheless, we tested its performance against our favourite, TP-Link Archer AX6000 (Wi-Fi 6) router with our new Wi-Fi tests to see how it compared.

We test in a three-storey,

Sydney townhouse with a 115/4 Mbps Telstra cable internet connection on the ground floor. We run Ookla's SpeedTest on an iPad Pro one floor up and two floors up. However, because Wi-Fi 6 routers have been maxing out performance at all levels we also transfer large, 2GB files using a Synology DS1019+ NAS to an Dell XPS 15 OLED laptop (with integrated Wi-Fi 6) while 4K Netflix was streaming to a TV and YouTube to two, old, Android tablets.

Impressively, the EXO almost scored top SpeedTest scores at all levels – only dropping when two floors up, by 10Mbps. Up close with NAS file transfers it managed 67Mbps which was only 1Mbps behind Wi-Fi 6. However, one floor up this dropped to 31MB/s (Wi-Fi 6: 43Mbps) and two floors up it dropped to 21.2Mbps (Wi-Fi 6: 36Mbps). While it can't match the Wi-Fi 6's large file transfer speeds at distance, these are great numbers which make

it one of the fastest AC routers we've ever tested. Very few power users will be lamenting slow speeds.

It's also that bit more practical than the original D-Fend with four usable ethernet ports plus USB 2 and USB 3. Our one gripe with the EXO hardware is that when the antennae are extended, it takes up a great deal of space.

Setting up is simple when using both D-Link's Wi-Fi app plus the separate, network-security focused D-Fend app although there could be better integration between the two when it comes to labelling networked devices. However, we were impressed with D-Link's cloud services being accessible with Google Single Sign-On as simply accessing the router's settings over the internet is potentially very useful. Most other features are standard fare for routers nowadays although D-Link's feature layout is

particularly intuitive and it's embracing Google and Alexa voice control more than its rivals.

But, what really makes this worth consideration is the McAfee security integration. While Wi-Fi 6 routers routinely offer extensive parental controls and security enhancements nowadays, McAfee provides an unlimited number of two-year LiveSafe subscriptions to every device that connects to it (for five years). This plus a \$100-lower price than the AX6000 make it a great alternative to those who don't need the range of Wi-Fi 6. ■ Nick Ross

Verdict

It's not Wi-Fi 6 but it's very fast and offers great-value security features for your network.





PRINTER

\$999 | WWW.BROTHER.COM.AU

Brother Inkvestment MFC-J6545DW

Brother's A3 MFD makes a play for being the ultimate SMB workhorse.

We rarely review printers as nowadays they tend to be commoditised, uninteresting, and seldom used in domestic settings. But Brother has turned our heads with a model that it hopes represents the best of breed for SMBs. Indeed, beyond the pun-laden moniker, there's much to admire.

The MFC-J6545DW is a multi-function device that is sturdily built and quite compact considering it's both capable of printing and scanning A3 images using automatic document feeders. You'll still need a large desk to support its 18KG bulk, but it's very quiet and the functionality it affords is well worth the space it takes up.

As we've seen across the market, inkjet is making many laser printers redundant. Their quality has always been better but now their running costs and speeds are competitive.

inkjets also have fewer parts to go wrong.

Nonetheless, running costs aren't inconsequential. Brother should be applauded for including two, full sets of full-sized ink cartridges in the box which, it says, will enable two years of printing. This translates as: a regular ink kit (3,000 mono, 1,500 CMY) plus an XL kit (6,000 mono, 5,000 CMY). That's a great deal for many SMBs but and a refreshing change from the old industry days of stingily providing a solitary, partially-filled set.

Setting the beast up is incredibly simple thanks to the 9.3cm colour touch-screen, sensible buttons and intuitive menu system. We also found that the smartphone app was one of the best designed we'd used to the point where we actually preferred forwarding documents and photos to our phone and printing from there. We also

used it to scan multiple A3 documents and images directly to our phones.

We're a bit less enthused about the physical connectivity which sees all wires connect deep inside the machine and then guided out through an overly-elaborate, labyrinthine cable-tidy system – you'll need long cables. Meanwhile Wi-Fi is only b/g/n which could theoretically slow down some networks.

But paper management and handling is superb. Brother cleverly uses landscape orientation for both paper feeding and printing which helps to save space and improve speed. But text prints at 15ipm (mono) and 11ipm (colour) which isn't very fast, especially in a market with page-wide inkjet nozzles that print as fast as the paper can travel over them. This is underlined by the two minutes, 37 seconds it

took to produce a colour photo on A4 glossy paper. While quality is good (perfect for brochures but not fine art) that's not quick.

Other features are notable if not revolutionary and include printing direct from cloud apps like Evernote, printing (and scanning) multiple pages on one sheet, saving workflows and documents to memory.

At \$999 and with a two-year RTB warranty, it makes for a good-value, very-usable, do-everything MFD that's both quiet and a joy to use – even if it's not very fast. ■ Nick Ross

Verdict

Laden with features that you'll actually use, this cost-efficient, A3 MFD is well designed but rather slow.





GRAPHICS CARD

\$400 | WWW.INNO3D.COM

Inno3D GTX 1660 Super

It's all about the memory bandwidth.

Now that Nvidia's Super RTX cards are out in the market, it's time for attention to turn to the GTX Turing cards. First up is the GTX 1660 Super. It's to be followed by the GTX 1650 Super in late November.

The short version of this review is that it's identical to the GTX 1660, with one significant and performance impacting change. Gone is the 1660's GDDR5 memory, replaced by GDDR6 on the 1660 Super. It might sound like a rather boring change, but as you can see in the benchmarks, this has the effect of pushing the 1660 Super a good 10-15% in front of the 1660 in many cases.

Like we saw with the other Turing GTX cards, there is no reference or Founders Edition card. Instead, Nvidia provided an Inno3D GTX 1660 Super. It carries over the same specification of the TU116 GPU found in the 1660. It's a cut down version of the one

found in the 1660 Ti. There's 1408 Turing CUDA cores paired with 6GB of 14 GB/s GDDR6 memory over a 192 bit bus. The end effect of this change is a massive increase in bandwidth from 192 GB/s to 336 GB/s. This gives it more bandwidth than the GTX 1660 Ti. The Super sees a small 5W power consumption increase to 125W. A single 8 pin power connector should make it easy to integrate into budget systems.

We're testing the Inno3D GTX 1660 Twin X2. Budget graphics card buyers really don't need expensive custom PCBs and extravagant cooling solutions. It's definitely a no frills card, though its dual fan cooler does an admirable job of keeping the card cool without resorting to annoying noise levels. It is audible under normal use, but no more so than any other fan in a typical system. It comes with a

triple DP 1.4 connectors and a single HDMI 2.0b port.

What really impresses is how it performs vs. the GTX 1660. The memory bandwidth alone means we're looking at a 10% performance improvement and higher in some cases. The 1660 is perfectly playable with high to maximum settings at 1080p. 1440p is doable, though it will require dialling back on some image quality. We don't have a GTX 1660ti on hand to retest, but referring to our launch benchmarks, we know that the 1660 Super is hot on its heels.

The Inno3D GTX 1660 Super Twin X2 is what we wish the GTX 1660 was when it launched. Price/performance has improved without having to rely on power and clock speed increases. We'll have to wait and see just how the upcoming competing AMD RX 5500 performs, but for now, the GTX 1660 Super is

our pick for a relatively affordable gaming graphics card. Yes, we'd like it to be a bit cheaper, but that's just the way Nvidia has priced Turing cards. If you're looking for a capable 1080p gaming card right now and don't want to spend big bucks, the GTX 1660 Super is the card to get. ■ Chris Swenczyk

LABS BENCHMARK RESULTS

3DMARK (TIME SPY)

NVIDIA GEFORCE RTX 2060	7932
INNO3D GEFORCE GTX 1660 SUPER TWIN X2	6423
ASUS GEFORCE GTX 1660 PHOENIX	5875
GIGABYTE GEFORCE GTX 1650 GAMING OC	3937
AMD RADEON RX 5700XT	9165
AMD RADEON RX VEGA 56	6986
AMD RADEON RX 590	5259

3DMARK (FSE)

NVIDIA GEFORCE RTX 2060	8879
INNO3D GEFORCE GTX 1660 SUPER TWIN X2	7020
ASUS GEFORCE GTX 1660 PHOENIX	6161
GIGABYTE GEFORCE GTX 1650 GAMING OC	4115
AMD RADEON RX 5700XT	11720
AMD RADEON RX VEGA 56	9100
AMD RADEON RX 590	6824

Verdict

The no frills GTX 1660 Super is the pick of affordable gaming GPUs, for now at least.





GAMING MOUSE

\$256 | WWW2.RAZER.COM/AU-EN

RAZER Viper Ultimate

Arguably the best wireless gaming mouse in the world right now.

Razer's Viper gaming mouse became an instant favourite among PC gamers when it launched earlier in the year thanks to its incredible responsiveness, thoughtful design and lightweight build. So how do you improve on something that's already near-perfect? Make it wireless, of course! It's also sporting Razer's brand-new Focus+ optical sensor, which is said to be 25% faster than competing technologies, the Viper Ultimate carries a mind-boggling maximum sensitivity of 20,000 dots per inch (even higher than the 16,000 DPI of its wired equivalent). Of course, that's likely overkill for most people, which is why Razer has included a button on the bottom of the mouse that lets you easily cycle through a number of different sensitivity settings. Along with an IPS (inches per second) rating of 650 (effortlessly out-tracking the 400 IPS rating boasted by Logitech's G Pro and G502 wireless gaming mice) and optical mouse switches that

provide a response time of .02 milliseconds, Razer Viper Ultimate is basically indistinguishable from a wired mouse in terms of performance. Speaking of tracking, Razer's Focus+ sensor can automatically detect changing surfaces without the need for calibration, and will also give you complete control over lift-off distance. A magnetic charging dock cleverly houses the mouse's USB dongle and, like the Viper Ultimate itself, sports full Chroma RGB lighting. It's also impossible to fault the mouse's ambidextrous design, which features eight programmable buttons and a weight of just 74g. Right now, Razer's Viper Ultimate is the wireless gaming mouse to beat. ■ Stephen Lambrechts

Verdict

A new champion in the wireless mouse stakes - whether for gaming or general use it's great.



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techradar.com



SINGLE BOARD COMPUTER

US\$59 | WWW.ROBOTSHOP.COM

Banana Pi Pro

How does this SBC compare to its similarly named competitor?

The success of the Raspberry Pi family of single board computers has spawned a large number of other low-cost SBCs, many of which can be considered compatible with the RPi at one level or another. Some competitors aim to provide RPi performance at a lower price, while others target their products at a higher performance level. From its name, it seems reasonable to assume that the Banana Pi family of products claims compatibility with the RPi.

However, a quick glance at the specification would seem to suggest that the Banana Pi Pro (sometimes called just the Banana Pro) doesn't compare too favourably with the Raspberry Pi on either specification or price. First impressions can sometimes be deceptive, though, so we were keen to take a more in-depth look and put it through its paces.

Right from the start, getting the Banana Pi to work wasn't quite as easy as we've grown accustomed to

with Raspberry Pi products. In fact we couldn't get it to boot at all, so we ended up consulting the support team, who suggested trying a different microSD card. Despite being sceptical – because the card we used was of the required class and worked on a RPi 3 B+ – swapping to another card got us up and running. The bottom line, therefore, is that it's rather annoyingly fussy in this respect.

For many applications, performance isn't everything with an SBC but some of the Banana Pi Pro's headline figures do appear to be somewhat dated, especially when we bear in mind that the Cortex A7 is a 32-bit architecture. The processor sub-system could be described as a two-core version of the four-core Raspberry Pi 2, with a slight boost to the clock speed.

The boot time wasn't as bad as we'd feared,

however; with Ubuntu, from power-on it took 36 seconds to the login prompt, and then a further 18 seconds until the complete desktop was displayed. Benchmarking with Sysbench, however, painted a rather grim picture. Calculating prime numbers up to 20,000 on both cores took 420 seconds, averaged over a few runs. By way of comparison, the Raspberry Pi 3 B+ completes this in about 90 seconds, and the new RPi 4 in 63.

Depending on your aims and aspirations, expansion capability could be as important, if not more so, than raw speed. While the Banana Pi Pro falls behind the RPi 4 in terms of the number of USB and HDMI ports, it has a DSI port for an LCD panel and a CSI port for a camera – RPi features that don't appear on all look-alikes. For those who want to dabble with hardware interfacing, it has that all-important 2 x 40-pin GPIO header. What's more, that header is RPi

compatible – again, not something that's universally true.

The BananaPi also has some interfacing options that aren't found on the RPi. First up, and most unusually for SBCs, is a SATA 2.0 port for interfacing hard disks or SSDs. For storage-heavy applications, this will offer a big improvement over a flash memory card – so if you have a spare disk, this could be handy.

Also unusual is its on-board infrared receiver and microphone, plus an analogue audio output. This could be handy if you intend to use the Banana Pi for some handheld applications.

■ Mike Bedford

Verdict

Lacklustre performance compared to modern Raspberry Pis, but with some interesting interfacing options.





AIO CPU COOLER

\$299 | THERMALTAKE.COM.AU

Thermaltake Floe DX RGB 360 Premium Edition

Excellent cooling performance and all the RGB you could ever wish for.

TT's newest AIO CPU cooler is its flagship in the range, and supersedes the Riing coolers – which are excellent and still widely available.

The new design has a lot going for it. Superficially it appears almost identical to the Riing range of coolers, but there have been some useful refinements. The Riing was always well regarded for its near-silent operation, and the new Floe DX is still among the quietest, but it sees a slight bump in fan speeds, from a max of 1400 to 1500rpm, now. While a small increase, the Riing was arguably most appealing for its quietness, rather than its performance relative to much of the market, so this increase in airflow is welcome. At the same time the new Floe DX is a little quieter – coming in at a maximum noise level of 23.9dB compared to 24.7 with the Riing. That's at maximum RPM, though, and

in regular desktop use when the fans aren't fully spooled up it's closer to 19dB. The pump speed is still 3600 RPM, which is typical and well enough.

Perhaps the most useful real-world improvement here is that TT extended the length of the head-to-radiator braided coolant tubes. They've gained almost 8cm in length (400mm, up from 325mm in the Riing), which opens up more placement possibilities, as well as relieving possible tension on the tubes in tight fitting installations.

Out of the box it includes the expected support for both AMD and Intel, with supplied brackets for each. The installation process was simple and without stress, with the documentation clear and concise.

Three quality fans are included, and must be attached to the radiator prior to fitting in the case. In

our test we installed them on the inside of the radiator, rather than facing outwards, thus choosing to fill the case – rather than the room it was in – with RGB colour. The radiator is just 27mm deep, which is relatively slim compared to others and again offers more scope for installation if space is a little squeezezy.

The other component in the box is a 5-port fan controller, which needs Molex power and a USB header on your motherboard. DIP switches need to be set based on how many fans you connect and where they are, and while the documentation was less than clear on how these should be set we soon figured it out.

Performance was excellent. Testing it with an i7-8700K at stock clocks it maxed out at just over 53 degrees with an ambient room temp of 25 degrees, which puts it right up with

the very best. Equally impressive was the OC result, at 72 degrees with the CPU at 4.7GHz.

Naturally, the RGB is class-leading OTT and outrageously excessive. And many will love that. The software is refined and simple to use, and quite a lot of fun to play with. There's even Alexa voice control, should that rock your boat.

But simply looking at performance it's exceptionally good, and at just \$10 more than the superseded Riing model, a no brainer if you want a great TT AIO cooler.

■ Ben Mansill

Verdict

Can handle the hottest CPUs with ease, and if you like RGB you'll be in paradise.





MOBILE PHONE

\$2,999 | SAMSUNG.COM/AU

Samsung Galaxy Fold

The most forward-thinking phone you shouldn't buy.

The arrival of the Samsung Galaxy Fold gives you the opportunity to own the future of smartphones and tablets, with a 2-in-1 design that just makes sense – if the bendable screen technology holds up.

It marries a tall, narrow 4.6-inch 'cover' display behind glass on the outside with the foldable, mini-tablet-like 7.3-inch 'main' display behind plastic on the inside. Samsung calls this the Infinity Flex Display, and its design really does dazzle.

The key to the Galaxy Fold's book-like foldable design is a 20-part, dual-axis locking hinge that prevents the display from overextending past 180 degrees. Whereas the screen is delicate, the hinge feels like it's been meticulously engineered to withstand abuse.

Opening and closing the Fold feels buttery smooth, and closing it ends with a satisfying magnetic click, like you've just closed up a book. Remember what it was like to hang up on people

with a flip phone or even an old telephone? That feeling is back – only now, you'll probably swallow them up in a video call.

Also coming back is smartphone heft. In its folded state, the Galaxy Fold is 17.1mm thick and weighs 276g; for comparison, the big-and-heavy Note 10 Plus is just 7.9mm and 196g. However, it's narrower than you might think, and despite its thickness it isn't hard to slip into a jeans pocket – it'll even fit into tight-yet-deep jacket pockets that other phones can't fit into, although there's no escaping the fact that it'll look like you're packing two phones back-to-back.

Unfolded, it's a reasonable 7.6mm thick. You'll find a fingerprint sensor, power/

Bixby key, and volume rocker on the right (all accessible when the Fold is open or closed), and two speakers at the top and bottom. It's easy to cover up these powerful Dolby Atmos stereo speakers when you're playing games or watching videos in landscape orientation. Pro tip: instead of uncomfortably choking up your grip, try rotating the Fold 180 degrees – most apps will rotate just fine.

When it's closed, an all-glass design envelopes the phone's outside. The glass is slippery, but we found its folded size so easy to grasp that we didn't feel the need to use the two-piece Aramid Fiber case that came in the box. This ease of handling is one of the things that struck us the most in

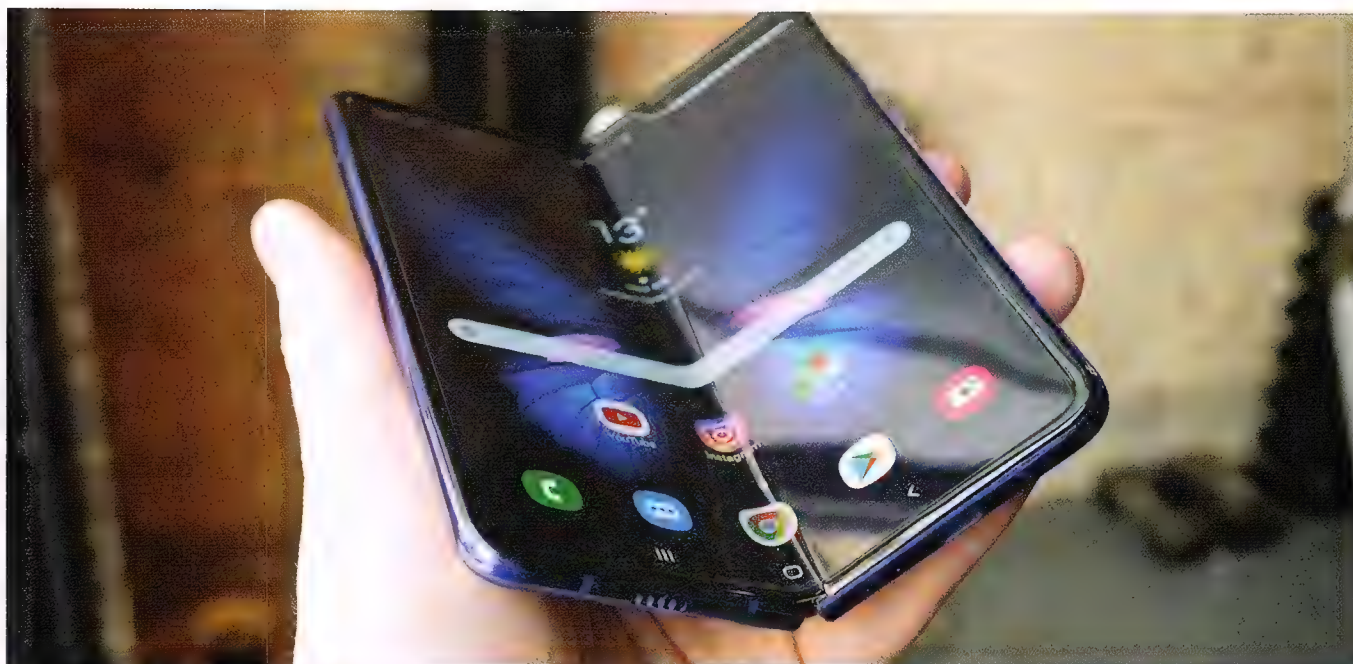
our testing – while everything else about the Fold has a futuristic vibe, its narrow size took us back to a time when phones were easy to hold in one hand.

If you love big screens, but are tired of juggling big phones, this is the biggest phone we've tested... and smallest (recent phone) at the same time. It's an idea that's been more than 10 years in the making and, as Samsung likes to say, went through 1,000 different prototypes. It's not a bad start, but there's surely more innovation to come.

SCREEN

Beyond the mesmerising foldable design, the main display is impressive with only a few technical caveats, illustrating the cutting-

"This phone is strictly for early adopters with money to burn and a penchant for impressing, and it'll end up in a drawer with Google Glass and other gadgets ahead of their time."



edge and its obvious downfalls.

The 7.3-inch display makes web browsing 1.4 times bigger than the Galaxy Note 10 Plus, and videos and games can appear 2.2 times bigger if they take up the full screen. It's the reason to own a foldable phone. Alas, most video in the traditional 16:9 aspect ratio will only be 1.3 times bigger, with big black letterboxing at the top and bottom.

We found the big screen better for reading, web browsing, and gaming thanks to its 4.2:3 aspect ratio. This mirrors the traditional 4:3 TVs we did away with 15 years ago, but going back makes sense: it offers a broader view and makes way for Multi-Active Window mode. We had three apps open at once, and it was fairly usable.

Samsung has outfitted the Galaxy Fold with HDR10+, which bumps up the contrast ratio considerably on supported video content, and made it bright enough to be solidly visible outdoors. You will find glare literally shines a light on the middle crease, indoors or outdoors, and you can feel the groove. The good news: like a notch, your brain will ignore it in time.

PERFORMANCE

Samsung Galaxy Fold isn't going to outpace the performance of current phones, as if this were a specced-out gaming desktop at an absurd price. You're paying for the screen innovation, not the latest chipset. That said, it matches the Galaxy S10 and Note 10 performance numbers thanks to its use of the Snapdragon 855 chipset.

Yes, Samsung could have opted to include the higher-end Snapdragon 855 Plus, but it stuck with the configuration announced in April. More importantly, it has 12GB of RAM that gives it a high yield when multiple apps are open.

It earned a multi-core score of 2,598, according to our Geekbench 5 benchmarking tests, with only the iPhone 11 Pro earning noticeably better marks (3,420). Without any noticeable lag, your foldable phone should be good to last – internally at least.

Testing proved that we could deplete the battery in a single day by gaming a bunch, binge-watching videos, and running multiple apps at once – basically running screen-on time to the max, the way a power user would on a long-haul flight.

VERDICT

The Samsung Galaxy Fold feels like the biggest sensation since the original iPhone – and, really, that's the only reason to take a \$2,999 risk on it. This phone is strictly for early adopters with money to burn and a penchant for impressing, and it'll end up in a drawer with Google Glass and other gadgets ahead of their time. Everyone else should wait for something cheaper, better, and more durable in a few months. ■ Matt Swider

Verdict

Delivers a 'wow' factor that no other phone offers today, and yet we'd only recommend it to early adopters.



"It feels like Google is taking a big step towards the homogeneity of other premium flagships such as the latest iPhones."



MOBILE PHONE

PIXEL 4 \$1,049 OR \$1,199; PIXEL 4 XL \$1,279 OR \$1,429 | [STORE.GOOGLE.COM](https://store.google.com)

Google Pixel 4 & 4 XL

This year's Pixel handsets have certainly come with some tweaks on Google's flagship formula, but are they all for the better?

It's almost immediately apparent that the design of both the Pixel 4 and 4 XL has shifted considerably away from that of their predecessors, with the two-tone rear entirely replaced by matte-glass surrounded by a textured aluminium bumper. While this is still a classy look, when combined with the new square camera bump, it feels like Google is taking a big step towards the homogeneity of other premium flagships such as the latest iPhones. The aforementioned bumper does make for a nice surface to grip onto when in use, and the matte glass feels pleasant to the touch, but these will likely both be buried in a case soon after you get the phone.

Flipping it over, you'll notice the first point of difference (of only two) between the regular handset and its larger counterpart. While the Pixel 4 has a 5.7-inch display at a 1,080 x 2,280 resolution, the 4 XL bumps this up to

6.3-inches and 1,440 x 3,040 pixels. Overall, this makes for a greater pixel density (537 versus 444ppi) on the XL and, theoretically, a sharper image, but in reality both P-OLED displays are perfectly capable of producing clear, vivid images and video. The upgrade to a 90Hz refresh rate for both handsets (which you can disable if you'd prefer to save a touch on battery life) is somewhat noticeable in standard practice, making for a smoother scrolling experience in social media for instance, but really shines when gaming.

PROJECT SOLI

These screens are surrounded by thin bottom and side bezels and an oddly prominent top bezel. The reason for this extra chunk (and distinct lack of notch) is to house Google's Soli motion-sensing and facial recognition technology, which both rely on radar – one of the new Pixel range's flagship features. Project

Soli has been in development for at least five years now, being publicly announced in 2015, and has essentially culminated in the ability to swipe your hand over your phone to skip forward or back when playing music, or silence your alarm or phone call. Frankly, this is rather underwhelming and we found the song-skipping to often activate when we didn't want it to, and the alarm silencing seemed a tad janky, although the phone's awareness of your proximity does mean that the 'always-on' display is only on when you're actually nearby enough to see it, which is neat. To be fair, there is room for these gestures to be added to in the future, with more app integration (scrolling web pages, perhaps?), and for improvements to be made to tighten its response. The technology itself is apparently capable of detecting ultrafine movements, even with thumb-forefinger gestures, so we're hoping this feature

will expand its usefulness.

The other reason for Soli's integration into the Pixel 4 lineup is for its Apple-esque facial recognition. Instead of the camera-based biometric security found in most competing phones (outside of the recent iPhones), these Pixels use radar to map and recognise your face, providing security that Google deems thorough enough to do away with a fingerprint scanner entirely. In practice, we did find the face unlocking to be snappy, and combined with the phone's ability to detect when your hand is approaching it in order to prep the radar and wake the screen, it makes for a rather fluid and organic interaction. With that said, unlocking it while it was laying flat on a desk or tabletop meant awkwardly hovering your face over it like some kind of blimp or resorting to entering your PIN code.

Also housed in the large top bezel is the selfie camera – a single snapper as



opposed to the Pixel 3's dual array, which also included a wide-angle lens. The depth effect in portrait selfies is now digitally produced rather than optically and the field of view is reduced from 97° to 90°, but honestly, these changes aren't all that noticeable in practice as Google's software is top-notch. Any downgrade in the selfie department is more than made up for in the primary snapper, which now utilises a dual camera setup to boost the already-stellar Pixel photo and video game to the next level. A second 16MP telephoto lens joins the existing 12MP main camera to enhance its zoom capabilities, low-light performance, and depth-of-field effects in portrait photography, and we found all three of these areas to be highlights of the fourth-generation Pixels.

Some further improvements in the software side include the ability to preview your HDR+ photos live (rather than having to see the results

after the shot's been taken), an astrophotography mode for shots of the starry night sky, and a Dual Exposure mode. This latter feature lets you modify the brightness of the background and shadows of your subject with independent sliders in order to better balance photos with blown-out backdrops or indistinct subjects. These extra abilities come courtesy of the processing power allowed for by the dedicated AI chip (Neural Core) which is also responsible for the new live captioning feature that annotates any audio source live, and will also power a much-improved Assistant (unavailable at the time of testing, but due sometime in the Summer).

PURE ANDROID

As always, you'll be getting the most stock Android experience available with the new Pixels, both arriving with the latest Android 10 in its sleekest form. The interface is intuitive, simple,

and snappy – something iOS users will enjoy if they switch over – and the phone's integration with Assistant and any Google smart home tech you've got set up is equally as immediate to use. Powering these handsets is 6GB of RAM and a Snapdragon 855, which isn't the latest mobile processor from Qualcomm but is still plenty powerful enough for almost any current smartphone task.

As for the second point of difference between the two handset variants, the regular Pixel 4 only has a 2,800mAh battery (a downgrade from the Pixel 3's 2,915mAh) while the larger 4 XL has 3,700mAh. As expected, the regular Pixel 4 doesn't have such a great battery life as a result of this, barely lasting until evening with average use, while the 4 XL will comfortably last the full day and change.

VERDICT

We would've liked to have seen certain additions (5G

network support and improved battery life, namely) and some of the new features are currently in the 'gimmick' phase – Motion Sense will likely join the existing Edge Sense (or 'phone squeezing') as an unused method of interaction. Both handsets have landed at a lower retail price than last year's models by \$150 and \$70 for the Pixel 4 and 4 XL respectively, and while we have some misgivings about them both, they still represent excellent value compared to some other premium flagships, particularly if you're keen on camera and AI prowess.

■ Harry Domanski

Verdict

A good step up for Google with excellent cameras and a few new funky features.



software

» APPS FOR ALL YOUR PLATFORMS



Windows SOFTWARE



Antivirus

Customize how threat protection and detection is handled.



Firewall

Configure firewall behavior, and access and connection rules.



AntiSpam

Customize how spam is detected and handled.



Tasks Scheduling

Customize your automatic scans.



Administrative Settings

Manage your product behavior.



Backup Settings

Adjust Backup behavior.



Exploit Prevention

Customize how application threats are handled.

Quick Controls

☐ Silent Mode

☐ Backup

☒ Backup Status Overlays

☒ Automatic LiveUpdate

☒ Smart Firewall

☒ Norton Tamper Protection

Norton 360

A surprisingly generous set of included features.

\$80/YEAR (STANDARD), \$100/YEAR (DELUXE), \$150 (PREMIUM) | AU.NORTON.COM

The revamped Norton 360 line includes a password manager, online backup software and storage and an unlimited-data VPN service. With the integration of LifeLock identity protection in the more expensive options, Norton is presenting itself as a one-stop shop for all your security and privacy needs.

As for the antivirus part of the package, the heavy system-performance impact that cursed Norton products a decade ago seems to be making a comeback, at least during scans. The software also comes with far fewer security tools than other brands' antivirus offerings. But if you're in the market for identity protection as well as antivirus software, Norton 360 with LifeLock protection can be a pretty great deal. All the new products include backup software, cloud storage, a password manager and a two-way firewall. All the Norton 360 products include unlimited VPN service, webcam protection and Dark Web monitoring. The top three products include various levels of LifeLock identity protection.

Norton 360 Standard costs \$80/year for a single PC, Mac, Android or iOS device (though it's not worth buying for a single mobile device) and adds webcam protection and LifeLock monitoring of your personal data on the Dark Web. It includes online storage of 10GB and gives you unlimited Norton VPN service for a single device, which isn't chicken feed – no other antivirus brand we know of gives you unlimited VPN data for no extra fee.

Norton 360 Deluxe costs \$100/year for up to five PCs, Macs, smartphones or tablets and adds extensive parental controls; 50GB of cloud storage; and VPN client-software licenses for up to five devices.

The more interesting one is Norton 360 Premium, a

souped-up version of Norton 360 Deluxe for 10 devices that lists for \$150 per year and comes with 75GB of online storage. This might be the one to get if you have a lot of devices – or a large family – but don't need or want LifeLock. All Norton antivirus products work with Windows 7 through Windows 10, macOS 10.12 and later, Android 6.0 Marshmallow or newer and iOS 10 or later.

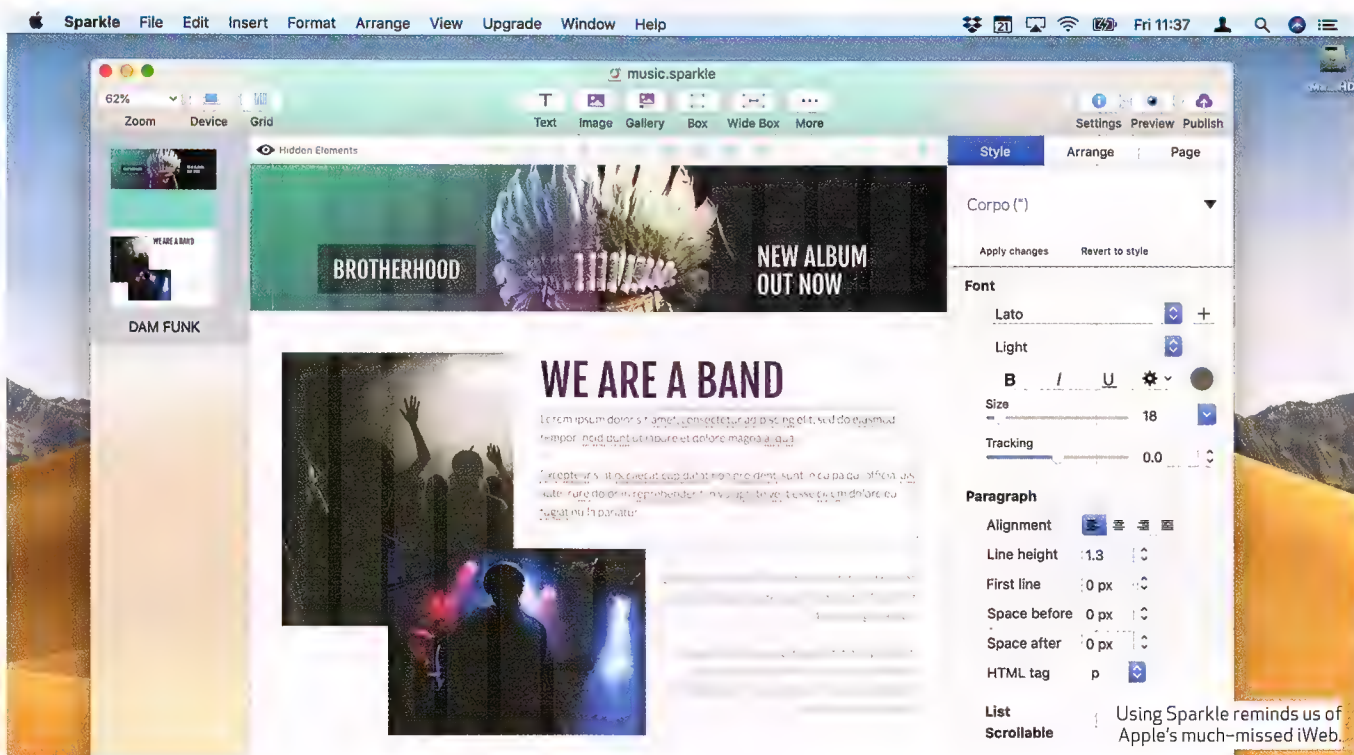
None of the new Norton 360 products have yet been tested by the major antivirus testing labs, but because they use the same Windows malware-detection engine as the previous lineup, existing lab results should be applicable. Norton is almost always in the top rung of lab results, alongside Bitdefender, Trend Micro and Kaspersky.

Norton detected every threat, both widespread and zero-day, in German lab AV-Test's Windows 10 tests from January through June 2019. It scored the same 100 percent in all previous AV-Test bimonthly rounds on Windows 7 or 10 in 2017 and 2018, averaging only a couple of false positives each time. No other antivirus brand we regularly review could match that, although Kaspersky stopped short of 100 percent only once over those 30 months.

Whether and which Norton antivirus products to buy depends on what else you need. If you're shopping around for a password manager, a VPN service or an online backup service, Norton's bundling of these products at no extra cost is tremendously appealing. And if you think you also need an identity-protection service, no other antivirus company offers such a compelling package. However, if you just need antivirus software, Norton is only one of a few brands that offer excellent malware protection. ■

Ben Mansill & Brian Nadel

Mac » APPS



Sparkle

Create great websites quickly and easily.

FROM \$46.99 | SPARKLEAPP.COM | NEEDS OS X 10.9 OR LATER

Good news – if you can make a document in Pages, you can make a website in Sparkle. It's a flexible and useful web design tool for people who want something other than a WordPress site. There are three versions: Basic, for one site of up to 10 pages; One, which removes the page limit; and Pro, which adds both Instagram and multi-site support.

The app opens with a blank page and an open toolbar with common items such as text areas and images, but the simplest way to use Sparkle is just to

download one of the free templates and mess around with it. The program's library contains some genuinely useable contemporary designs, an area that lets down some other web creation apps, and editing these really is just as simple as editing a document in Pages. The interface is largely the same too, with the familiar toolbar at the top and inspector panels for changing item properties at the right.

It's all very straightforward, and you can easily paste code from other apps or sites using the Embed icon, which creates a space for you to post website code – SoundCloud music, YouTube links, Buy Now buttons and so on.

Publishing your finished site is simple with a standard FTP setup. If you go for Sparkle Pro you can also publish directly to Instagram and integrate Google Analytics.

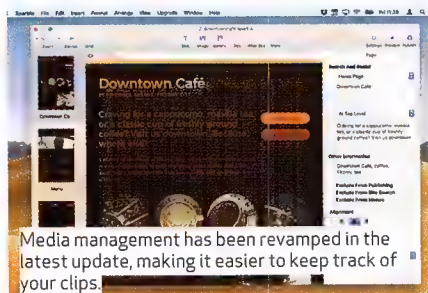
RELATIVE DIMENSIONS

There are a few niggles over and above Basic's 10-page limit. You can't change

the device dimensions: for example, its tablet resolution is 960x480 but an iPad mini is 1024x768 and a 12-inch Pro is 2732x2048. The fonts you're given are web-safe ones, not necessarily the ones you want from your Mac (although you can add them manually). And while the app creates responsive websites for different screen sizes, it can end up creating different versions of the same page for desktop and mobile: rather than just changing the Live Preview when you switch devices, it switches the editor mode too. Layout changes you make to mobile aren't applied to the desktop version.

These are minor irritations, however. Sparkle is very easy to use, creates impressive results and reminds us a lot of Apple's long-gone iWeb. ■

Carrie Marshall



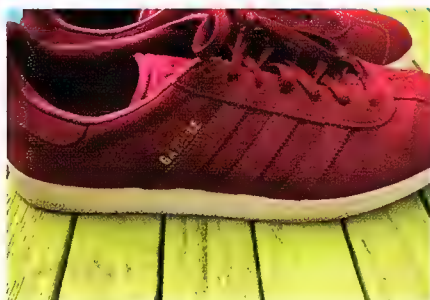
Media management has been revamped in the latest update, making it easier to keep track of your clips.



App Store » iOS APPS



My Lists



Ebay Stuff

1



Santa, Maybe

Q Search



White Company Ride On Car

1



Pink Range Rover

1



Pale Blue Retro

1



Magpie

Take notes with your camera.

\$7.99 (OR 99C/MONTH) | GETMAGPIE.APP | NEEDS IOS 11 OR LATER

Magpie is a variation on the Notes app, but instead of text notes or audio notes, it's designed with photographs in mind. That means it's best on your iPhone; it's fine on iPad but the more portable your device, the more convenient Magpie becomes.

Magpie describes itself as a digital scrapbook, 'the beautiful lovechild of Apple Photos and Notes', although we think it's closer to Pinterest. It's ideal for those of us who tend to use the Photos app as an ongoing collection of interesting things, only to wonder what on earth those things are and where they came from. With Magpie, when you see something you want to remember or share, simply snap it. Unlike the Photos app, you can then add some context so it'll still make sense later: your comments, perhaps, or the URL for a product, or the map location.

You can get images into the app in several ways. The camera is the most convenient, of course, and as you'd expect you can import from Photos. On iPad you can also drag and drop from Safari, which is handy for saving things from online shops or social media.

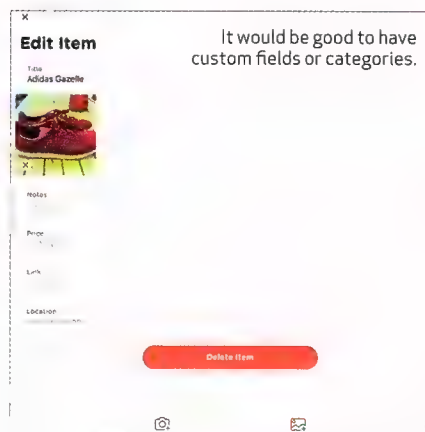
It's simple to set up and to use: just

create a list and add as many items to it as you like. You can add multiple images to each individual item, which is handy if you want to record multiple views of a tourist attraction or fashion item. You can also share your lists with others, either for them to view in their own app, or by posting to a social network.

TAKING NOTE

It works well, but the info you can store is limited. Each item gets just four fields: price, link, location, and a free-text notes field. This is fine for a few items, but if you start recording lots of things the lack of tagging or categorisation is likely to be an issue. It'd be nice to be able to group your lists in the sidebar too, rather than just reorder them.

Perhaps that'll be addressed in the



future. For now, Magpie is a useful app, and there's a one-week free trial so you can try it before signing up. ■

Carrie Marshall

"Magpie describes itself as a digital scrapbook, 'the beautiful lovechild of Apple Photos and Notes', although we think it's closer to Pinterest."

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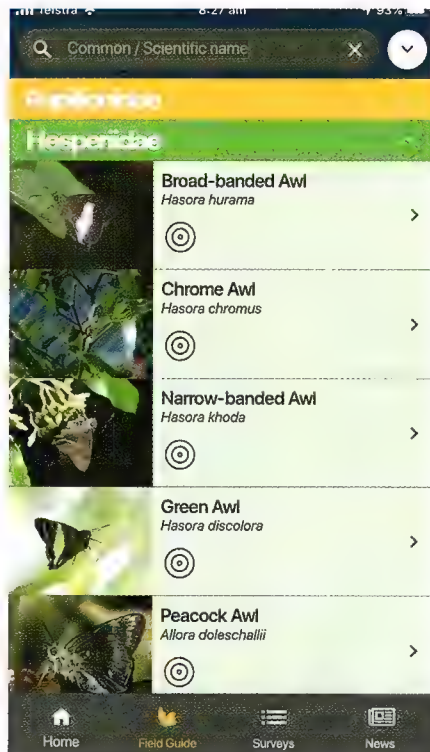
Google Play » ANDROID

Butterflies Australia

You're my butterfly, sugar baby.

FREE

Butterflies Australia has been built with government funding (which apparently still exists?) in order to record all the different species of butterfly in Australia. If you're not an avid butterfly watcher, or familiar with the processes involved in cataloguing butterflies, then a lot of the functionality is going to be locked off from you – the 'Survey' option immediately confused me. But regardless of your investment in butterfly populations, the app's field guide, and its list of every type of butterfly found in Australia – complete with photos, maps, descriptions and lists of behaviour traits and habitat preferences – is cool. The app might feel like a glimpse into a world you're not necessarily familiar with, but the catalogue they've built up is impressive. The photography is great throughout, and it's a cool way to wrap your head around the scope of our butterfly population. That might not be a thing you realised you cared about until the app is actually on your phone, of course.



Gradient Photo Editor

Different shades.

FREE (PREMIUM \$7.99 A WEEK) | GRADIENT.PHOTO

Gradient recently went low-key viral for its 'transform into a celebrity' function – the exact sort of low-grade, basic meme option that's meant to go viral by comparing you to a celebrity you look nothing like (it's flattering even considering the possibility of sharing a facial structure with Taika Waititi, after all). There's a whole app beyond that one mode, though, and it's a bit of an odd one. This is a basic photo manipulation app that locks some of its functionality behind a ludicrously overpriced premium option, and has some extremely dubious options beyond that. Being able to see what I'd look like as a Simpsons character by giving myself bright yellow skin is fun; being able to darken or lighten my own skin realistically is a more problematic option. Basically, Gradient is a fun photo manipulation app as long as you don't take it the least bit seriously: please don't pay an exorbitant weekly fee to remove blemishes from all your photos and give yourself a digital nose job.



Guardian Daily

Guarded recommendation.

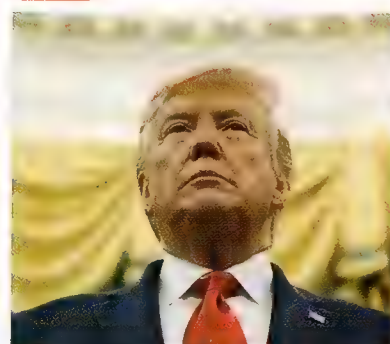
FREE | WWW.THEGUARDIAN.COM/AU

The Guardian's new app is designed to streamline the way you access your news, and while it's not likely to fully replace the site or the regular app, it does a good job of keeping you informed on what's happening that day. It divides news up between a few categories – Top Stories, National, World, Financial, Journal, Culture, Life and Sport, plus the crosswords – and presents the most important stories of the day. The Guardian's a go-to news source for me, and I can see myself opening this app once a day to catch up on the top stories, even though it's intentionally cutback in other areas – there's no search function, for instance, or podcasts, or really anything beyond lists of headlines and stories. But, ultimately, that's a good thing – the app's sense of focus makes it feel closer to picking up a daily newspaper and flicking over the most important stories. It's great if you just want to be kept informed without doing a deep dive into months of depressing articles about Trump. ■

James O'Connor



World



US Justice department opens criminal inquiry into origins of Russia investigation

Trump has complained that his campaign was improperly targeted, but critics say department is being used to chase conspiracy theories



Archman 2019.09

There's hardly an issue when Mayank Sharma doesn't run into an Arch-based desktop distribution. Does this offer any benefits over others?

FREE | [HTTP://ARCHMAN.ORG/E](http://archman.org/e)

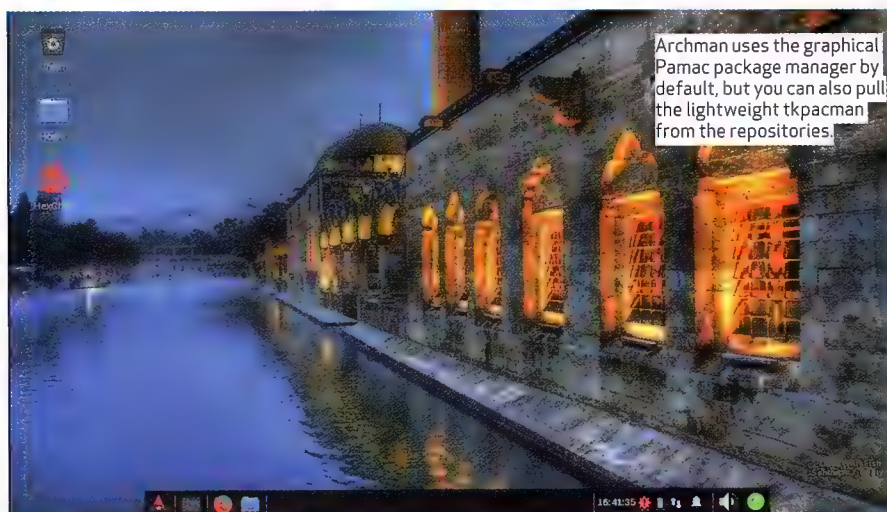
Developed by a mature but non-English speaking team of Arch specialists, this distro has a couple of things that aren't particularly obvious. For starters, the project seem to support multiple desktop environments, but their latest release on test here is only available with the Xfce desktop. On that front, Archman 2019.09 includes the latest Xfce 4.14 edition that includes four years' worth of improvements and polish.

Archman's desktop includes the standard desktop furniture. There's the centralised Xfce panel at the bottom, which features the Whisper Applications menu and the standard fare of icons including a workspace switcher, a clock and a notifications area. Interestingly, besides icons for the home folder and trash, the desktop has one for the HexChat IRC client. This seems strange, since an IRC client isn't considered as an often-used app on a regular desktop distro.

It's not that the distro is short of apps. The default Archman install contains all the usual desktop productivity apps such as Firefox, LibreOffice and GIMP, besides a good collection of nifty little utilities. Some of the offbeat apps it bundles include the uGet downloader, the Parole media player, the Quod Libet audio player and the Ex Falso audio-tag editor. The distro relies on the Calamares installer to help you anchor it to your disks. It gives you the option to create a small swap partition or a larger one that can house the current environment, that comes in handy when you put the computer to sleep.

SAME OL' SAME OL'

One of the ways distros distinguish themselves from their peers is with their custom apps. Archman doesn't give much to write home about on this front. It does include its Archman Settings Manager that you can use for some basic administration tasks. But



"The distro brings very little to the table, especially when you pit it against its much mature Arch-based peers."

this app has been forked from the Manjaro Settings Manager and instead of adding to it, Archman has removed one of its most useful modules. Gone is the Kernel module, one of the highlights of the tool in Manjaro, which enables inexperienced users to switch to a different kernel with a single click.

Besides the Settings Manager, Archman's GitLab page also hosts several other custom projects, but these aren't included in the distro. For instance, there's a WhatsApp client that would have garnered some extra points for the distro had it been included in the distro's official software repositories, at least.

Instead you'll only find artwork, configuration and a handful of hardware drivers in Archman's custom repository. The project's website takes pride in the fact that the distro is a "pure" Arch offering with only some optimisations. It doesn't detail nor quantify these improvements, but for what it's worth

Archman performs incredibly well running inside a virtual machine even with limited resources.

On the face of it there's nothing wrong with the distro; Archman is an Arch-based desktop that runs a slightly customised Xfce desktop and ships with all the usual productivity apps. But this straightforwardness is also its weakness. Archman offers little else besides the convenience of a ready-to-use, Arch-based, Xfce-sporting desktop. The distro brings very little to the table, especially when you pit it against its much mature Arch-based peers. It pales compared to our favourite Arch-based distro Manjaro, which has set quite a high benchmark for usability. Manjaro also has a vibrant and active community, flush with documentation to handhold new users, which you wouldn't find in Archman. Also, while we were impressed by Archman's performance, lightweight Arch derivatives like ArchLabs do a much better job. ■

BEST DISPLAYS

UNDER 27-INCH

Keith Martin reviews
a selection of displays
that won't stress your
wallet or swamp your
desk.





As well as price, display and ports, you need to assess a monitor's physical adjustment options.

While it's easy to get distracted by the latest high-end, high-price 4K and 5K displays, most of us find it better to place something more humble on our desks. This applies even more when you're setting up a home office, and the price of 24-inch HD-level displays has reached very affordable levels. We selected four monitors at the 24-inch level, as well as a 22-inch and 27-inch model, and put them through their paces to see which comes out on top once cost, build and performance have been taken into account.

Price is an important factor here, but it is still important to select a display that will do a good job. Never forget that you will be staring at your screen far more than any other bit of technology that you own. Well, possibly apart from your iPhone, but that's a discussion for a different time.

The ergonomics of a display are also

important, from the initial setup – which proved to be quite easy with all five of the devices we tested – through to the methods of adjusting them, both in physical terms (monitor tilt and so on) and in how they can be fine-tuned for best display quality. It's easy to overlook these things, but they do make a difference to your ongoing satisfaction.

We test the color accuracy of displays to gain an objective understanding of their capabilities. If you're looking for something just for surfing online and using standard productivity software, precise color rendering won't be your prime concern, but you should still aim to avoid displays that struggle to show things accurately. These five displays all did a good job (and achieved very similar scores) considering their price range, so they're all worth your consideration in that respect.

Things to consider...

Everything you need to know before getting started.

1 DISPLAY HEIGHT

Having your monitor positioned appropriately – with your eye level roughly a third of the way from the top, facing straight on to the screen – helps with posture, but it also helps you see color and contrast accurately. This is particularly important with VA-based LCD panels, but it's good practice for all displays.

2 INPUT TYPES

This is a world of acronyms, but the different display connector types all have their own advantages and disadvantages. VGA is strictly old-school and should be avoided unless you have no choice. HDMI is fairly universal, but DisplayPort can drive screens at a faster refresh rate. If there are two DP sockets, you can daisychain from one screen to another for extra screens. USB-C is an "all in one" connection for data as well as display.

3 USB TYPES

If your PC or Mac has USB-C, and you aren't using a discrete graphics card, then it makes sense to get a display with this as an input type. If not, then if you want to use the USB hub in one of these displays you'll need a USB-A to USB-C cable. The USB-A ports in these are only for 'downstream' connections with peripherals.

4 COLOR SPACES

Adobe RGB and sRGB are two color "spaces" that help show color consistently. sRGB is not as wide as Adobe RGB, but it's the de facto online standard so it's vital a screen can display this at or near 100%.

How we tested

These are budget-friendly displays, but they should still do a good job. We used a Datacolor Spyder5Elite colorimeter to check a number of factors, particularly color accuracy. On-screen controls are often difficult, so we explored making adjustments with these, and we also considered the range and ease-of-use of their physical adjustments.



▲ HIGHER...
EIZO COLOREDGE
CS2420
EIZO.COM
FROM \$1,499

Where image quality and precision is paramount and price isn't an object, Eizo's ColorEdge CS2420 is a great, if costly, option.



▼ ...OR LOWER?
BENQ GW2480
BENQ.COM
AROUND \$200

If price is critical then the BenQ GW2480 is worth considering. It's a couple of years old but still a good wallet-friendly option.

Test 1 Ease of use

Setup and adjustments.



Physical ease of use may seem a strange test for a device that just sits on your desk, but if you need to tilt, turn or raise your screen, or perhaps even use a VESA mount to put it on a wall or support arm, this is important. For basic requirements these monitors are all quite acceptable, but not all have the full range of adjustments.

Assembly was easy, although the AOC stand can disconnect if not "clicked in" firmly. The AOC, Dell and Samsung displays all offer tilt, height and swivel adjustments. The Acer and Philips only offer tilt; swivel can be achieved by sliding the display and stand together, but you'll need a box to change their height.

If you want to rotate to portrait orientation both the Dell and the Samsung allow this. VESA mount compatibility is another niche requirement, but all apart from the Acer include it.

"If you want to rotate to portrait orientation both the Dell and the Samsung allow this."

ACER R241Y	AOC 24E1Q	DELL P2219HC	PHILIPS 278E9QJAB	SAMSUNG S24H85
★★★★★	★★★★★	★★★★★	★★★★★	★★★★★

Test 3 Display quality

Screen type and performance.



Color rendering precision is a critical concern for designers and video editors, but everyone wants their display to make at least a good stab at showing things accurately. When checking this out, the first thing to note is the kind of LCD panel used. VA LCDs as used in the bigger Philips display are cheaper, but they suffer from contrast and hue shifts when viewed from an angle. The Philips display is curved to

counteract this, but you should still sit centrally for the best performance. The Acer, AOC and Dell use the higher-end and more expensive IPS form of LCD, while this Samsung monitor uses a PLS LCD – very similar to IPS but with some minor advantages.

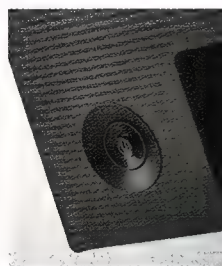
Color performance on the monitors was measured with a Datacolor Spyder5Elite colorimeter. All of these displays did reasonably well considering the price range, but AOC and Philips pipped the rest of the competition at 78% and 80% of Adobe RGB, respectively.

"Color performance on the monitors was measured with a Datacolor Spyder5Elite colorimeter."

ACER R241Y	AOC 24E1Q	DELL P2219HC	PHILIPS 278E9QJAB	SAMSUNG S24H85
★★★★★	★★★★★	★★★★★	★★★★★	★★★★★

Test 2 OSD controls

Adjusting the settings.



Monitor "on-screen display" controls, or OSD for short, can be awkward to use, both in terms of hitting the right buttons to navigate through the options and finding the settings you actually need. None of these displays use touch-sensitive sections of the bezel for this, which is a relief. We much prefer physical buttons for this.

The Samsung and Philips displays use a single rear-mounted joystick to access and navigate through the OSD options. Using these proved easy after a bit of familiarisation. The Dell, AOC and Acer displays use an array of buttons. Both AOC and Acer use one of these for power, making it easy to turn the screen off by mistake. The AOC's are shown on the front which helps avoid this, but we triggered Acer's power switch a few times by mistake during testing, which was a little frustrating.

"AOC and Acer use one of these for power, making it easy to turn the screen off by mistake."

ACER R241Y	AOC 24E1Q	DELL P2219HC	PHILIPS 278E9QJAB	SAMSUNG S24H85
★★★★★	★★★★★	★★★★★	★★★★★	★★★★★

Test 4 Port types

Connection options and limitations.



This isn't so much a performance test, but it is a very important part of how a particular display will satisfy your specific needs. First of all, if your Mac is equipped with USB-C then the Dell and Samsung displays stand out from the rest of the field as the only ones featuring this input option; the others will require adaptors. However, if this isn't a concern for you, then the AOC, Dell and Samsung units all offer

a good selection of ports: DisplayPort in and out, HDMI, and in AOC's case DVI as well. These also have USB passthrough and power, from a USB-B port in AOC's case and USB-C in the Dell and Samsung.

The Acer and Philips displays have no USB ports, so they don't act as port hubs for data or device charging. Like the AOC these offer an old-fashioned VGA port for analogue video connections, but their modern HDMI port (and in Acer's case DVI as well) should be used in preference.

"The Acer and Philips displays have no USB ports, so they don't act as port hubs for data or device charging."

ACER R241Y	AOC 24E1Q	DELL P2219HC	PHILIPS 278E9QJAB	SAMSUNG S24H85
★★★★★	★★★★★	★★★★★	★★★★★	★★★★★

THE WINNER

Dell P2219HC

Good performance and input ports include USB-C.

The monitors examined in this group test all have their good points, and that's on top of their affordable price tags. You'd probably be happy with any of these, but a couple did stand out above the rest. Samsung's S24H85 wasn't the slimmest, but it is higher resolution than the rest. Yet the cost is also highest by far, so it couldn't take pride of place.

At 22 inches, Dell's P2219HC is slightly smaller than the others, but it's a strong performer with good connectivity options. (Dell also deserves praise for using no polystyrene in its packaging, something we wish other manufacturers would

consider.) It didn't achieve top scores in our Datacolor colorimeter tests, but the differences between all these units was just a few percent.

USB-C isn't a requirement for everyone... yet. But if you don't need it now you may for your next PC or Mac. This Dell display includes USB-C as a display input type and of course for passthrough USB data as well. If you prefer DisplayPort, this (and the Samsung, to be fair) also supports daisy chaining monitors; link a second DP-compatible display to this one without running another cable from your Mac.



With daisy chaining support and a USB-C port, the Dell is our winning display.

How do they compare?



THE SPECS	ACER R241Y	AOC 24E1Q	DELL P2219HC	PHILIPS 278E9QJAB	SAMSUNG S24H85
WEBSITE	acer.com	aoc.com	dell.com	philips.com	samsung.com
PRICE	\$199	\$125.58	\$236	\$249	\$449
SCREEN SIZE	23.8 inches	23.8 inches	21.5 inches	27 inches	23.8 inches
RESOLUTION	1920x1080	1920x1080	1920x1080	1920x1080	2560x1440
DISPLAY PORTS	1x HDMI, 1x DVI, 1x VGA	1x HDMI, 1x DVI, 1x DisplayPort, 1x VGA	1x HDMI, 2x DisplayPort, 1x USB-C	1x HDMI, 1x VGA	1x HDMI, 2x DisplayPort, 1x USB-C
USB	None	4x USB-A, 1x USB-B	4x USB-A, 1x USB-C	None	3x USB-A, 1x USB-C
WEIGHT (WITHOUT STAND)	2.54kg	2.8kg	3.05kg	4.59kg	4.1kg
LCD PANEL TYPE	IPS	IPS	IPS	VA	PLS
ADOBE RGB	75%	78%	75%	80%	77%
SRGB	98%	100%	97%	100%	98%
EASE OF USE	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
OSD CONTROLS	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
DISPLAY QUALITY	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
PORT TYPES	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
OVERALL	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★

Note: The final verdict scores reflect the overall opinion of a product and are not necessarily an average of the criteria listed in the table.

feature » host your own password server



HOST YOUR OWN PASSWORD SERVER

Take control of how your passwords are synced and where they're stored, with Nick Peers.

Everyone needs a password manager. You simply can't get by online these days relying on a handful of easily guessable passwords – just take a trip to <https://haveibeenpwned.com> to confirm your trusted passwords of yesteryear have almost certainly been exposed by now.

The value of a password manager can't be overstated, whether it's generating unique, random, lengthy passwords that are almost uncrackable, or storing them securely in a vault protected by strong encryption and – if you're diligent – extra layers of security. But it's not necessarily all good news. Where is your password vault stored, and who can access it?

Services like LastPass and 1Password that make it easy to sync and access passwords between mobile, desktop, and browser store your encrypted vault on their own online servers. They argue their “zero knowledge” model, where they have no access to your password or the keys that encrypt your file (which is done locally on each device), keeps them nice

and secure. Great, but that's an awful lot of trust you're placing in their hands – they're not immune to attack, and while LastPass maintains no encrypted vault data was compromised when its security was breached in 2015, hackers were still able to access the files, putting any vaults protected by weak passwords at risk.

So, how do you ensure your passwords can't fall into the wrong hands? You could go old school and use a single password manager app on your PC, where the vault is encrypted and stored locally (perhaps backed up to a USB key, stored in a fireproof safe). That's almost watertight, but at what cost? Convenience, for one: Copying passwords by hand on your phone or using the clipboard to transfer passwords from app to browser is slow.

The solution lies somewhere between foolproof security and the convenience of being able to sync and access passwords on the go.

Over the page, we reveal how to find the perfect balance, with the help of one of three password managers.

feature » host your own password server

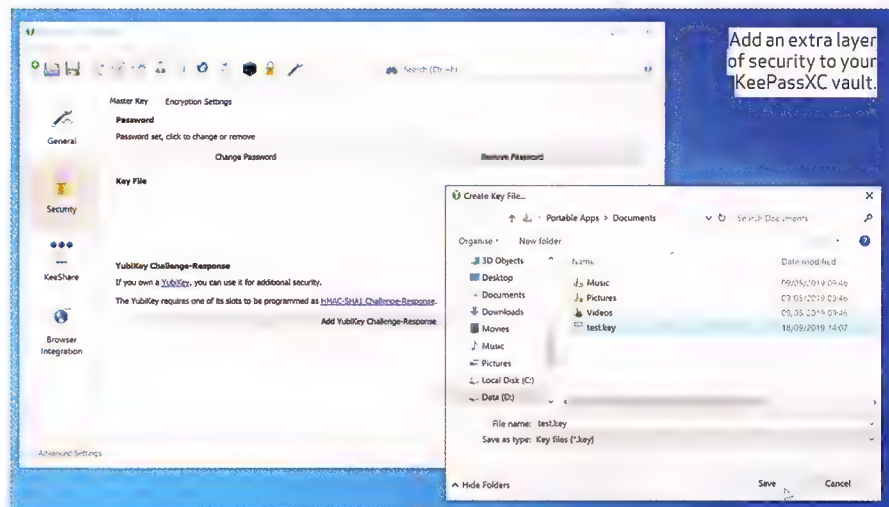
What should you look for in your finely balanced password manager? First, it must be cross-platform – apps for Windows, macOS, and Linux, plus browser add-ons, and mobile support on iOS and Android. Second, you need full control over where your passwords are stored – whether your own hosted server or choice of cloud storage provider. Third, we want better transparency from our password managers, which is where open source comes in. And fourth – not mandatory, but preferably – support for additional forms of authentication to protect your password vault, such as 2FA or key files.

THREE OPTIONS HIT THE SPOT

We've settled on three potential solutions. The first is KeePass, the open-source desktop password manager. If you already store all your passwords in a KeePass database, it makes sense to continue using this feature. Check out the box opposite for the quickest way to get a multi-platform, cloud or network-synced password setup using KeePassXC.

If you plan to store your database online for always-accessible syncing, we strongly recommend making use of KeePassXC's additional security options to protect your file if the server it's stored on is compromised. You can pair it with a physical YubiKey, or create a special key file that's required alongside your password to open the file, so even if your password is subsequently discovered, the vault remains off limits.

To add a key file, choose "Database > Change master key," click "Add additional protection," then "Add Key File." Click "Generate" to create the file – we suggest saving this in a different location from your password file. One option would be to store it on a different cloud platform to the one you usually use.



BUILD ME UP BUTTERCUP

Our second solution is Buttercup (<https://buttercup.pw>). It checks all the platform boxes, with support for Firefox and Chrome browsers. Unlike KeePass, which relies on third-party mobile support, all Buttercup apps are native (and completely free). Like KeePass, there's no proprietary server on which your password vault is stored, but support for syncing via the cloud is baked into Buttercup's DNA.

This is evident from the moment you download and install the Windows client. On first launch, you're invited to click "Add archive" to set up a new vault. From here, you can create a new archive – which you store locally – or choose "Connect Cloud Sources" from the pop-up menu to create an online archive for syncing purposes.

The Windows desktop client supports just four services: Dropbox, OwnCloud, Nextcloud, and WebDAV (which includes Box among its supported clients). Google Drive is conspicuous by its absence, despite the fact it's an option in both the browser add-on and mobile apps – as a

workaround, if you have Backup and Sync installed on your computer, generate a new local archive, and save it in your Google Drive folder to make it accessible to your browsers and mobile devices.

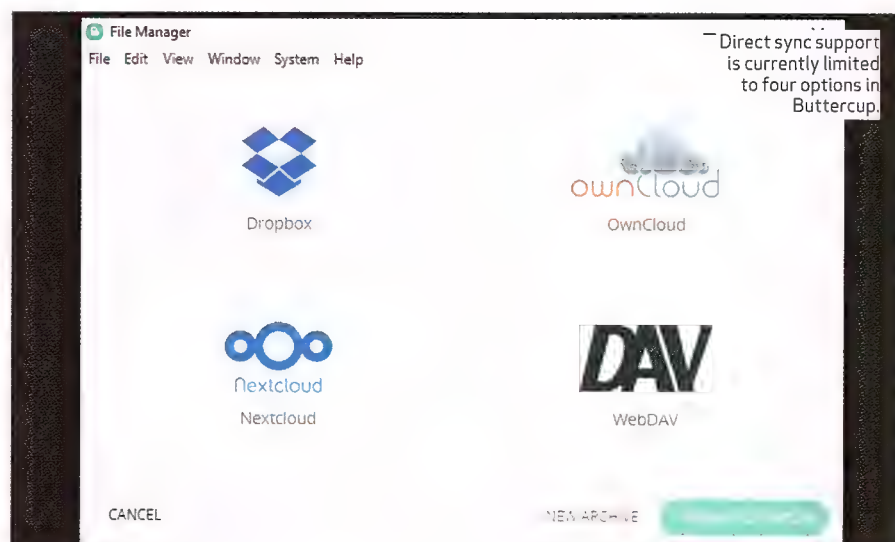
Next, enter a master password to protect your newly created archive – the usual caveats apply: Make it as long as possible, and try to avoid making it obvious. That said, it's the one password you need to remember going forward, so don't make things too difficult for yourself. Click "Confirm" and retype the password before clicking "Confirm" again.

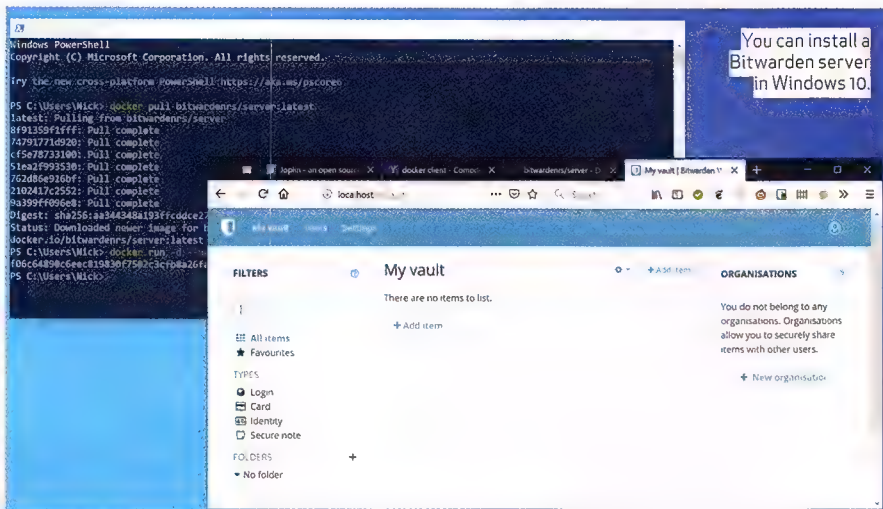
One of Buttercup's neat features is that it makes it easy to manage multiple vaults at the same time – you can create more than one and switch between them easily. Use this to segregate passwords from each other – you could, for example, keep all your online passwords in one vault synched to your cell phone and browser, while offline passwords remain stored on your PC only.

CREATING & MANAGING PASSWORDS

By default, the desktop application is designed primarily to organise your passwords into folders (or groups), plus create new passwords from scratch. Here, only title, username, and password fields are provided – if you plan to manually create web logons, you need to click "Add new field," enter "URL" for the "Label," then type the web address into the "New Field" box to convert it into something that works with the Buttercup mobile app or browser add-on.

Look out for the magic wand button next to the password feature – clicking this enables you to generate a random password of 10–50 characters. This can be random characters or words – choosing characters enables you to select what types to include, from alphanumeric to spaces, dashes and





underscores, and symbols. Click "Generate" to keep generating passwords until you find one you like, then click "Use this" to record it.

If you're migrating from another password manager, you may be able to import your passwords into Buttercup to save time having to recreate them from scratch. Choose "File > Import," where you'll find options covering 1Password (.1pif), KeePass (.kdbx), LastPass (.csv), Bitwarden (.json), and previous Buttercup installations (.csv). 1Password and KeePass users are prompted for the master password from the original vaults.

EXTEND TO MOBILE AND BROWSER

Most of your logins will, of course, be linked to websites – while we've shown it's possible to set these up in the desktop application, a far better option is to install the browser add-on and/or mobile apps. These work in a similar way. First, click "+" to add a new archive or link to an existing one. If you select "System > Enable Browser Access," you can link your browser add-on to a password file stored on your PC; otherwise, it's a case of selecting your

chosen cloud provider (including Google Drive, of course) to log in, browse, and select the archive file.

After entering your master password, you're prompted to give this archive a name – this is purely for identification purposes, so doesn't need to match its file name. Now your archive is connected to all your devices, you can update it from browser, mobile, and desktop, but sometimes changes are slow to appear – to force a sync in the desktop application, for example, choose "View > Reload."

When you next log into a website using your browser, Buttercup pops up a prompt to save the username and password into its archive: Click "Save" and a new tab opens with the new entry details showing name, username, password, and URL. Review and edit these if necessary, then select your archive followed by a group (this is mandatory, so consider creating one in the desktop application), before clicking "Save New Entry."

Once your entries start to build up, it's time to take advantage of Buttercup's password-filling features.

Sync in KeePass

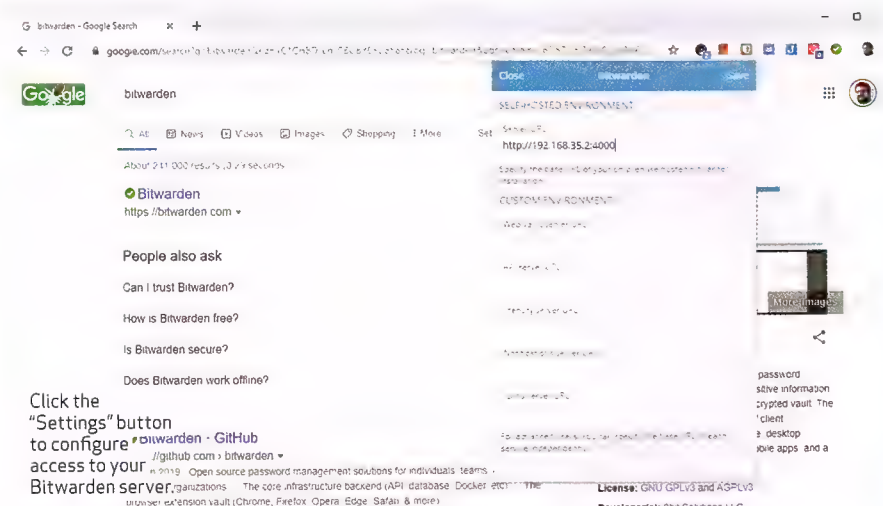
There are ways to keep your database in sync between multiple desktops and mobile devices using the main KeePass application, but if you're looking for a straightforward, cross-platform approach, consider choosing the more user-friendly KeePassXC fork (<https://keepassxc.org>), which has been designed to make things easier for multi-platform use (Windows, Mac, and Linux; Chrome and Firefox browsers; plus mobile).

KeePassXC works with existing KeePass databases, so once installed, start by loading it in. Next, enable Firefox and Chrome-based browsers to access the passwords in the database by navigating to "Tools > Settings > Browser Integration" and checking the appropriate box. See <https://keepassxc.org/docs/keepassxc-browser-migration/> for additional instructions if required.

Keeping the database in sync with other desktop clients can be achieved by simply storing your database file inside a folder accessible to all, whether that's a folder on your NAS for syncing exclusively over your local network or the folder used by any cloud provider, such as Dropbox or OneDrive, installed on your PC.

When it comes to extending KeePassXC to your cell phone, there's no native application provided, but the KeePassXC team recommends one of KeePass2Android for Android users and Strongbox Password Safe for iOS. Both enable you to sync your mobile vault with the desktop file using supported providers (you need the requisite cloud app installed on your phone).

Both Android and iPhone apps work in a similar fashion: Open the app and choose to add an existing database when prompted. Select your cloud provider from the list, then browse to your synched database file and select it. Provide your password (and select your key file if necessary) to gain access to your saved passwords from your phone. iPhone users should navigate to "Settings > Passwords & Accounts > AutoFill Passwords" to configure Strongbox to automatically fill login boxes, too.



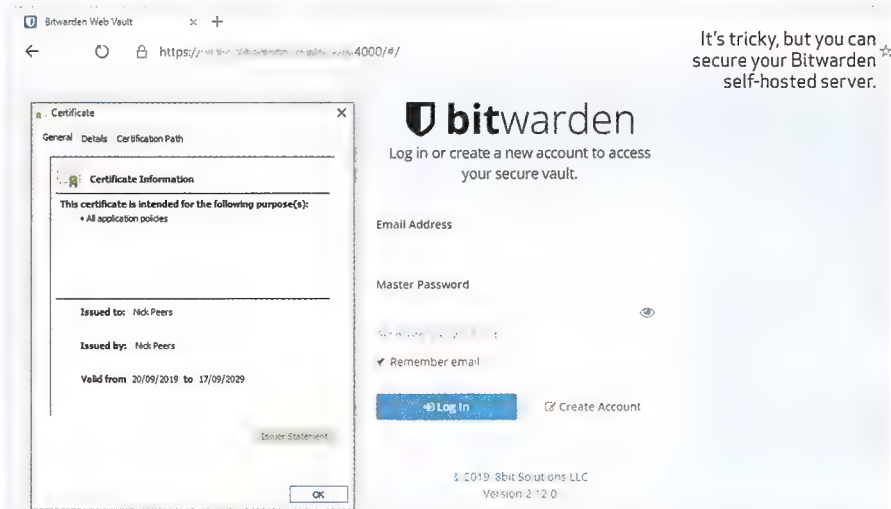
Install Bitwarden on your NAS

For Bitwarden to work effectively, you need 24/7 access to the server. Thanks to their support for Docker, both capable Synology and QNAP NAS drives are the perfect host for your new Bitwarden server. Synology users can follow the guide at www.synoforum.com/resources/bitwarden-self-hosted-password-manager-using-bitwardenrs-server-image.3/, but QNAP users need to adapt the instructions there for their own setup, as follows...

If you're using QNAP, first verify in File Station that there's a shared "Container" folder, then add a subfolder inside here called "Bitwarden." Next, open Container Station, choose "Create" and search for "bitwardenrs" then click "Install" next to the "bitwardenrs/server" entry at the top. Leave "Latest" selected and click "Next."

Give it a suitable name, then reduce the "CPU Limit" to 20 percent and "Memory Limit" to the minimum 64MB before clicking "Advanced Settings." Select "Network" – by default, NAT mode shares your NAS's IP address with Bitwarden (click "Add" under port forwarding to forward port 4000 on the host to 80 on the container); if you want to allocate it a unique IP address on your network, select "Bridge" under "Network Mode," followed by "Use static IP," and pick an unused IP.

Select "Shared Folder" and click the second "Add" button above "Volume from host." Next, click inside the "Volume from host" box to browse for the "Bitwarden" folder you created, then type "/data" into the "Mount Point" box. Click "Create," review the settings, and click "OK." To monitor the installation, select "Containers" under "Resource." Once downloaded, the Bitwarden docker appears here. Click its name to view the console as its setup and basic configuration takes place. When you see a reference to "[rocket:rocket[[[INFO] GET/alive:" the server should be up and running. Open a web browser and type the IP address you allocated earlier into it, and you should find yourself at the web vault login screen, ready to continue.



It's tricky, but you can secure your Bitwarden self-hosted server.

Look for the Buttercup logo appearing next to login boxes in your browser – click this and you should see the relevant username and password appear, enabling you to click to quickly populate the boxes. Alternatively click the "..." button to reveal options to copy username or password to the clipboard, plus reveal the password behind its mask. If you're signing up to a website for the first time, right-click inside the password field, and choose "Buttercup > Generate password" to create a strong random password.

When it comes to mobile use, iPhone users can configure Buttercup in the same way as Strongbox (see boxout on previous page) to automatically fill passwords in any app as well as your browser. While a little rough around the edges, Buttercup has most bases covered, but if you want the best of all worlds – and are prepared to work for it – read on.

SECURE WITH BITWARDEN

Our final solution is our current go-to password manager: Bitwarden (<https://bitwarden.com>). This open-source multi-platform offering is the closest to LastPass and its ilk, and works in a similar way, with your passwords hosted on its own servers by default. But what sets it apart is the fact it's possible – if tricky – to host your own Bitwarden server, so all your passwords are stored on a trusted device at home.

The official guide for installing a full-blown self-hosted Bitwarden installation is found at <https://help.bitwarden.com/article/install-on-premise/> – but this is geared toward large organisations, and comes with some overblown system requirements. It's also a complicated setup, but thankfully some enterprising folk have developed a prebuilt version. Bitwardenrs is written in Rust, and is both relatively simple to set up (at least initially) and undemanding on your

system: 10MB RAM and negligible impact on your CPU.

For this to work, you need to employ the services of Docker. Ideally, you'll set this up on an always-on 24/7 device – the box on the left reveals how to do this on a QNAP or Synology NAS – but you can also install it on your PC. You need a 64-bit CPU, 4GB system RAM, and hardware virtualisation enabled in the BIOS. You can run Docker on any modern version of Linux, but our instructions focus on Windows 10 (in particular, Windows 10 Pro, Education, or Enterprise 64-bit).

INSTALLATION STEPS

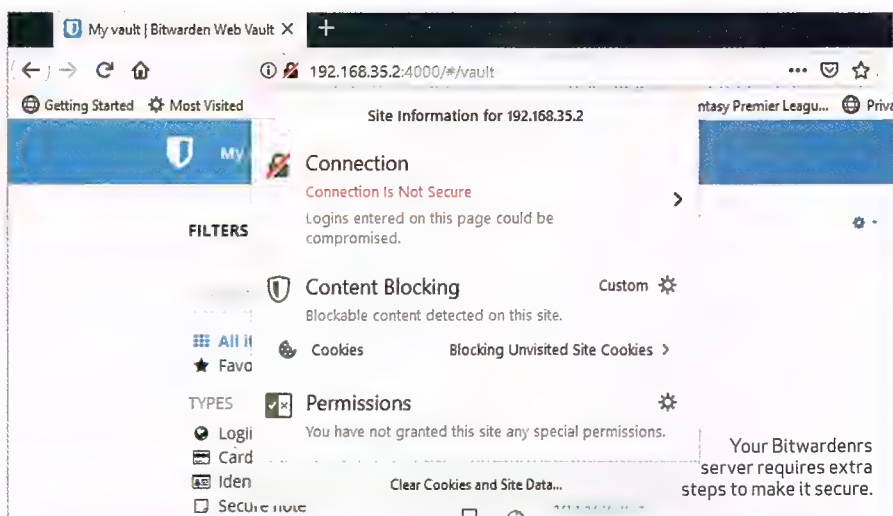
If your PC fits the bill, type "Windows features" into the "Search" box, and click "Turn Windows features on or off," then enable both "Containers" and "Hyper-V" before clicking "OK" and rebooting when prompted. Now install Docker Desktop via <https://hub.docker.com> – click to sign up for a Docker Hub account if you don't already have one. At the quick-start screen, download and install Docker Desktop for Windows (all 835MB of it). When prompted, leave the default boxes checked (Bitwardenrs/server is a Linux container) and click "OK" to complete the installation. If prompted, update Docker. Once done, make sure Docker is running (look for its Notification area icon), then open a Powershell window before issuing the following command:

```
# docker pull bitwardenrs/server:latest
```

This downloads the images required to run Bitwardenrs. The next command creates a quick and dirty Bitwarden install that has no security, but works instantly:

```
# docker run -d --name bitwarden -v /bw-data:/data/ -p 80:80 bitwardenrs/server:latest
```

That's it for basic setup and configuration. If you now open a web



"You have the flexibility of an online password manager with the security of knowing exactly where your passwords are stored."

browser on your PC or any device on your local network and type **"http://192.168.x.y"** (substitute "x" and "y" for your PC's IP address), you should find yourself at the Bitwarden web vault, where you can create your account and log into it. One note: Chrome refuses to connect to the web vault in this configuration (see <https://github.com/bitwarden/web/issues/254>).

LINK TO BITWARDEN

Assuming you're happy to access the Bitwarden server exclusively over your home network insecurely, then you're done with setup and configuration. This configuration allows you to access your vault securely when outside your home network (just don't explicitly log out of Bitwarden while on the road), but you won't be able to sync any new logins you create with the server until you're back inside your network (simply select "Settings > Sync > Sync vault now" to force a manual sync if it doesn't happen automatically for any reason).

If you want external access to the server, you first need to configure a domain to point to your Bitwarden server – one simple solution is to make use of a free dynamic DNS service, such as No-IP (www.noip.com). You also need to implement HTTPS security with an SSL certificate – see the final box for details.

In the meantime, existing Bitwarden users should start by transferring their passwords from the cloud to their new server: Log into <https://vault.bitwarden.com>, select "Tools," and

click "Export Vault." Read the warning, leave "json" selected, and enter your master password again before clicking "Export Vault" again. Save the file somewhere secure, then log out, and close the browser tab.

Type your server IP address along with any required port number – you should see the same interface as found at <https://vault.bitwarden.com>, but this is pointing to your local server. Log into your new account, and this time select "Tools > Import data." Select "Bitwarden (json)" as the import file format, then click "Browse" to select your exported file, followed by "Import." Wait while it's uploaded, and your passwords imported. Once done, you are ready to start configuring your apps and browser add-ons.

If necessary, click "Settings" to log out of your web-hosted Bitwarden account. At the login screen, click "Settings," where you'll see the fields required to access your self-hosted environment (if left blank, Bitwarden defaults to its online servers). You only need to fill the top field: Enter **"http://192.168.x.y:4000"** or whatever your IP address/port number combo is, click "Save," and log in as normal.

From here, Bitwarden should largely behave as normal – we recommend visiting "Settings > Two-step login" in the web vault to set up 2FA using an authenticator app such as Google Authenticator or Authy for extra security, but otherwise you're done. You have the flexibility of an online password manager with the security of knowing exactly where your passwords are stored. ■

Secure your server

The basic Bitwarden server is up and running, but there are key elements missing: One, there's no security, and two, you can't access the server outside your local network. To see what's required, visit the Bitwarden wiki (https://github.com/dani-garcia/bitwarden_rs/wiki). The best solution is to use a third-party certificate such as Let's Encrypt, but it's complicated to set up – start your search at <https://blog.linuxserver.io/2019/01/15/self-hosting-bitwarden/>.

If, however, you're not intending to use Bitwarden on your iPhone or Android, you can generate your own self-signed certificate as outlined in the wiki (see "Using a Private CA and making SSL certs work with Chrome") in conjunction with the domain name you're using to point to your server.

This involves OpenSSL, and Windows users must first download and install the full version of Win64 OpenSSL (<https://slproweb.com/products/Win32OpenSSL.html>) – choose Win32 OpenSSL and adapt the commands below if you're running Bitwarden on Windows 32-bit.

Once installed, type "environment" into the "Search" box. Click "Set the system environment variables" followed by "Environment Variables." Click "New" under "System variables," name it "OPENSSL_CONF" and click "Browse File" to select "C:\Program Files\OpenSSL-Win64\bin\openssl.cfg." Once created, select "Path" under "System variables" and click "Edit" followed by "New" to insert "C:\Program Files\OpenSSL-Win64\bin\". Click "OK." You should now be able to open a Command Prompt window, navigate to a suitable location (such as "C:\keys"), then issue the commands listed to create the required keys. When generating the "Bitwarden.ext" file, substitute "Bitwarden.local" with your own domain name.

Next, switch to the "Enabling HTTPS" section of the wiki for additional steps to follow – if you're running Bitwarden on a NAS, visit www.synoforum.com/threads/378/ (Synology) and https://github.com/dani-garcia/bitwarden_rs/issues/465 (QNAP) for more help with setting things up.





\$1,000 build it challenge

Can we build the best upgradable system for under a grand?
Christian Guyton shows the way.

We're back with another featured build, and this time our focus is customisability. We wanted to make a straightforward, versatile system to act as a launchpad for future expansions. As such, we had a budget to work with: \$1,000. And we stuck to it. We decided early on that integrated graphics would be the way to go; we've got the space to add a dedicated GPU (or any other expansion cards that strike our fancy) later, if we want.

Flexibility is king here, but our system needed to be a capable PC in its own right, too. A mix of old and new components proved to be the cocktail we needed to create the perfect system for this task, although we'll look back at the end and see whether there's anything we could have done better. We'll also be taking some time to break down the directions in which this system could be upgraded, whether it's to become a high-powered gaming rig or a music-editing system.

That placed a few caveats upon us. First off, we needed a motherboard that was ready for upgrading, that meant plenty of DIMMs and PCIe slots, along with M.2 support, and the ability to take new Ryzen CPUs. We're going with AMD rather than Intel for our processor, due to the availability of newer AMD chips with integrated graphics. We also needed a PSU capable of handling those extras, and a case with room for more drives.

We're using a current-gen Ryzen processor with a last-gen motherboard, which might have you worrying about compatibility issues. Have no fear - we can rectify this with a few simple BIOS updates. This is where it gets complicated, though. X470-series motherboards can support either first-gen and second-gen Ryzen chips, or

second-gen and third-gen, but never all three at once. Assuming your X470 board didn't come with the latest BIOS updates installed, you need a 2000-series Ryzen CPU and a USB flash drive. Consider these add-ons to the build that we won't be mentioning in the ingredients list - they won't be used in the finished build, but you need them to get the system up and running.

PARTS LIST

PART		PRICE
CASE	COOLER MASTER MASTERBOX Q500L	\$79
MOTHERBOARD	GIGABYTE X470 AORUS ULTRA GAMING	\$238
CPU	AMD RYZEN 3 3200G	\$139
CPU COOLER	AMD WRAITH STEALTH	\$N/A
MEMORY	16GB (2X 8GB) CORSAIR VENGEANCE LPX DDR4-2666	\$119
PSU	450W CORSAIR CX450 80+ BRONZE	\$75
BOOT DRIVE	500GB CRUCIAL MX500 SSD	\$86
STORAGE DRIVE	1TB WESTERN DIGITAL BLUE HDD	\$59
OS	WINDOWS 10 HOME	\$140
TOTAL		\$935

"A mix of old and new components proved to be the cocktail we needed to create the perfect system for this task"



CPU COOLER

**AMD WRAITH
STEALTH**

\$0

It's free! The Wraith Stealth cooler that comes packaged with the Ryzen 3 3200G at no extra cost is actually a really good little cooling solution. It's simple to install, has a low profile that will fit in just about any case, and easily provides the cooling necessary for low-pressure computing with integrated graphics. It's still just air cooling, making it weaker for overclocking purposes, but we're not going to be overclocking this build anyway. The Q500L case has room for a small AIO cooler if we decide to upgrade, too.

CPU

AMD RYZEN 3 3200G

\$139

The cheapest chip in the Ryzen 3000 range, this comes with four cores, a base clock of 3.6GHz, and its own cooler (see above). Most importantly, it's got the integrated graphics – Radeon Vega 8 – that will power this rig. AMD claims this CPU can hit 4.0GHz in overclocking, but we've got reservations, especially as we're only using the stock cooler. That's OK, we've got no plans to overclock this build, and at less than \$150, this is exactly what we need.

RAM

**CORSAIR VENGEANCE LPX
16GB (2X 8GB) DDR4-2666**

\$119

We can stop singing the praises of Corsair's excellent Vengeance LPX line whenever we want, honest, but we just don't want to. It might not be as flashy or as fast as other memory – with no LEDs and a simple black metal finish – but this kit will serve us well. We contemplated a gentler 8GB, but 16GB for less than \$120 was too good an offer to pass up. The 3200G does benefit from fast memory, but we want value for money, so we've opted for a 2,666MHz kit of two 8GB DIMMs. Simple, but effective.



MOTHERBOARD

GIGABYTE X470 AORUS ULTRA GAMING

\$238

No, we're not using an X570 board, even though we are using a third-gen Ryzen. The new AMD-compatible motherboards are still prohibitively expensive, so we've opted for a cheaper X470 one. Gigabyte's Aorus Ultra Gaming has everything we need, and leaves lots of space for upgrading. We've

got room for more drives, a more powerful CPU, more memory, and any sort of PCIe expansion, be that a GPU, soundcard, or something else entirely. With no other flashy lighting around, this will be the only source of RGB effects inside our case – it's going to be a muted affair.



SSD



CRUCIAL MX500 500GB

\$86

Crucial always has it covered when it comes to SSDs. This time around, we're using its MX500, giving us half a terabyte of SATA storage to play with. This will be our boot drive, containing the OS and immediate file storage. We did look into using a smaller M.2 SSD for our primary drive, but even the launch of NVMe Gen4 hasn't lowered the prices of older M.2 drives enough for this low-cost build, so we're sticking with SATA for now. 500GB isn't quite enough for a full system, though, so we've enlisted some backup.

HDD

WESTERN DIGITAL BLUE 1TB

\$59

...and here it is. Western Digital's HDDs are still some of the best in the business, running quietly and not drawing too much power from your build. A terabyte of storage for just \$60 is a steal, too; a far cry from the pricey, bulky drives of yesteryear. The Q500L can support up to four SATA SSDs or two HDDs, so we've still got room for one more SSD on those drive brackets, should we decide to upgrade - alternatively, there's plenty of space on the motherboard for a speedy M.2 drive.



PSU

450W **CORSAIR** CX450 80+ BRONZE

\$75

Power supply prices are in constant flux, so this part of the build is nebulous at best. Really, we just recommend using whatever 140mm PSU you have to hand or can get cheaply online. We're using Corsair's CX450, as it's a good little power brick that comfortably provides all the wattage this system will need; anything in excess of 500W would be overkill. The CX450's low price means that it isn't modular, which will leave us with some excess cabling to deal with, but that's not the end of the world. If you do happen to have a modular power supply, go right ahead and use that instead for a slightly tidier build.



CASE

COOLER MASTER MASTERBOX Q500L

\$79

It's almost TARDIS-like in its complexity, seeming capable of fitting more inside its little metal frame than should logically be possible. The customisation options will be seen as a boon to some and utterly pointless to others. Yes, you can unscrew and remount the front I/O toward the rear of the case. Why would you? Well, that's not a question for us to answer, because we're not doing that. What we are doing, however, is nodding with satisfaction that we picked one up for a mere \$79 online. Good job, us.

Ready to build

Once you've got all of your components ready, follow our step-by-step guide to assemble this versatile \$1,000 PC.



1 PREPARE FOR BATTLE

Our preparation time is going to be a little more detailed this time around. All the usual rules apply: Make sure you've got a nice open surface to build on, a small bowl or other container to keep loose screws in, and all the tools you're going to require for this build (namely a Phillips head screwdriver, cable ties, and some thermal paste). There's one more thing to consider, though: You're going to have to set up the motherboard outside the case, so the BIOS can be updated before we assemble the system. Slot in your chosen Ryzen 2000 processor by lifting up the metal retention arm and dropping it into place before resealing it, then fit a stock cooler. You'll also want to put any sticks of RAM on the board now, to prevent potential issues with booting the BIOS. With that done, you can place the motherboard on a heat-resistant surface and connect it to the power supply. Turn it on, and make sure you can reach the BIOS screen. You shouldn't need a drive attached at this stage – as long as you can access the BIOS, you'll be able to do everything you need to do to update the motherboard's compatibility.



2 FLASH AND THUNDER

The Gigabyte X470 Aorus Ultra Gaming needs three BIOS updates. On a different PC, go to www.gigabyte.com, locate the motherboard's support page, then scroll to the BIOS updates, starting at F2 and ending at F42d. Head into the BIOS and check your version. If the board is new, it should be F1. We're leaping to F31, followed by F40, then F41. If you've got F31 or F40, you can jump ahead. Download the file, unzip it, and slap it on a flash drive. Plug it into the X470 board, select "Q-Flash" in the BIOS, then "Update," and locate the file on the flash drive. Once updated, restart, then repeat the process for F40, then F41. F42d primarily just fixes AMD compatibility issues for *Destiny 2*, and Gigabyte advises against it unless necessary. Once F41 is installed, swap out the CPU to the Ryzen 3 3200G, and check the BIOS acknowledges it. If it does, unplug everything and move on.



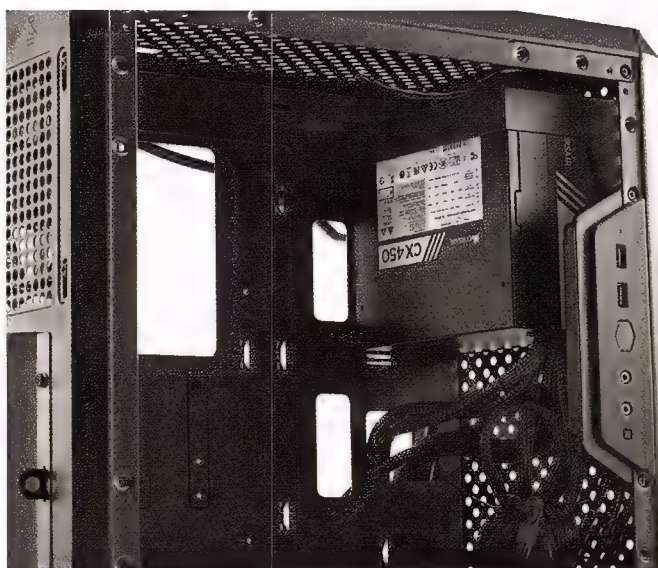
3 OPEN 'ER UP

The MasterBox Q500L is something of a strange beast in the world of computer cases, with its removable front I/O, vertical PSU mounting bracket, and feed-through power cable. The I/O can be switched to different sides of the case, but we're going to be leaving it in the default position for this build; therefore, when you strip down this case to get ready to build, just leave the I/O in place, and tuck the cables out of the way. The PSU bracket, however, can come out – remove the magnetic dust filters from the case, detach both side panels, then unscrew the bracket from the perforated metal frame of the case. Set the bracket aside for now – we'll be needing it later on. There's not much else that has to be done at this stage; leave the case fan cable tied up (it gets in the way of the motherboard installation otherwise), and remove the drive mounts behind the motherboard plates, setting them both aside for later, too. We are ready to start building!



4 COPY PASTE

Set the case aside, and get the motherboard ready to go. Unless you have an antistatic work surface, use the box the X470 came in as a workbench. Your processor should already be in place, so grab the Wraith Stealth cooler that came with it – be careful when removing it from the box, as there's a layer of thermal paste on the bottom. Make sure the correct AMD bracket is fitted to the underside of the motherboard, then screw down the cooler on top of the CPU, making sure all four screws are tight. Next, pop open the claps on the second and fourth DIMM slots heading away from the CPU socket (labeled DDR4_1 and DDR4_2), and insert the Corsair Vengeance LPX memory, pushing down on both ends until it clicks into place. If you installed the RAM earlier, give yourself a pat on the back. On to the next step!



5 MOUNTED AND LOADED

Take the bracket you set aside, and screw the CX450 PSU into place, making sure the long side of the bracket is on the same side as the PSU fan. When the PSU is installed, the fan should face outward through the case's dust filters. For the actual installation, put the case on its side and line up the bracket in its original position. Before screwing it in, feed through the power extension cable, and plug it in. When it's time to screw the bracket in place, ensure it's lined up properly; there is a subtle line on the case exterior that shows where the PSU needs to line up. Take care not to damage the front I/O's cable connectors – remember that the I/O can be removed and put back once the PSU is in place.



6 A TIGHT FIT

The MasterBox Q500L has an unusually pronounced bezel around the window panel, which, combined with the bulky PSU bracket, leaves only a narrow space to slide in the motherboard (don't forget to fit the rear I/O shield to the case first). We found the best option was to insert it diagonally, rotating it as you go. Fitting it under the rear case fan is also a struggle, as there's little room to maneuver. Once it's inside, fit it on to the central mounting peg, and screw it down to the nine stand-offs, first double-checking that the rear I/O is lined up correctly. Once done, connect the motherboard and CPU power cables by feeding them behind the board, then back out of the closest hole in the mounting plate.



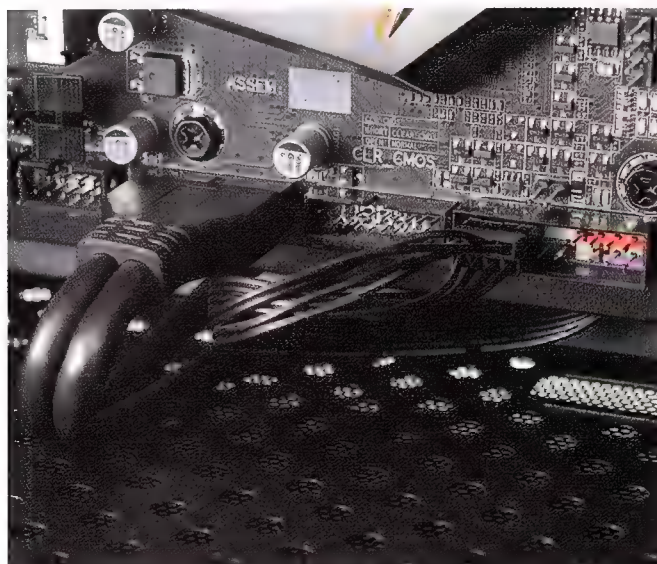
7 DRIVE BY

This section is mercifully quite simple. Take the two drive mounting brackets from the case, and screw the Western Digital HDD to one, and the Crucial SSD to the other. They will be mounted at right angles; the HDD should face to the left once installed, while the SSD will face downward. Due to the PSU placement, this case is a bit top-heavy, so we fitted the HDD to the lower bracket with the SSD above it, but you can align them the other way around if you like. Reinstall both brackets to the case by slotting them in on the right-hand side, then securing the thumbscrew on the left. Simple! We'll get ahead of the game with cabling here, too. Connect the accessory cables from the power supplies – you need two, as the Corsair CX450's multi-connector cables won't reach far enough – then plug in the SATA connectors and feed them to the far-left of the case, before bending them around the edge of the motherboard plate, and connecting them to the board in slots 0 and 2 (labeled on the board), making sure the SSD is in slot 0, because it will be our boot drive.



9 MEMORY SETUP

Back into the BIOS we go. We're going to get everything set up here now the system is built. Get the system plugged into your display and enter the BIOS. Our first step is to restore the default optimized settings; you can do this with a simple click on the BIOS's exit page. If you bought your board second-hand, this step is vital; otherwise, it's still worth doing to clear out any possible niggles. Next, we need to check our memory is running at speed. It should be active at 2,666MHz; it might manage to hit this by itself, but if not, switch on the XMP profile under memory control. You can check the operating speed outside of the BIOS using a system monitoring program, such as CPUID. Lastly, check the boot priorities; both of your drives should be blank at this stage, but make sure that the Crucial SSD is at the top of the boot priority list.



8 MIDDLE MANAGEMENT

With all our components set up, this build needs some tidying. The first stage is to separate the unused cables from the PSU, neatly bundle them together, secure them with a cable tie, and tuck them behind the front I/O. The Q500L is a good case, but it lacks space for concealing surplus cables. With no PSU shroud and minimal cable routing space behind the motherboard, we'll have to settle for tying up our loose cables like this. Leave the front I/O cables loose; the USB and HD audio cables need to be threaded along the bottom of the case behind the motherboard plate, then brought through to be plugged in. As for the tiny front I/O control connectors, we found it best to plug them in directly, then draw back the slack, and tie it up with the rest of the bundled power cables. There are plenty of clips on the rear of the motherboard plate for you to secure cables back there.



10 INSTALL WINDOWS

You need your copy of Windows 10 on a USB drive, as this system doesn't have a DVD drive (unless you have one lying around). It's a fairly simple process: Plug in the USB drive, fire up the system, and follow the installation instructions. Make sure the OS is installed on the MX500 SSD, and delete any partitions on either drive. We recommend going with custom rather than express installation, and turn off any features you don't want to engage in your version of Windows, such as Cortana's personal assistant settings, or personalised ad data. Once installed, make sure it boots properly, and check that the HDD is also accessible in the file explorer. If you're serious about performance, now is the time to stress-test your build with benchmarking software such as Prime95 or Cinebench. Otherwise, this build is complete, so let's take a look at the numbers....



1 We stuck with the single case fan that comes with the MasterBox Q500L, but there's ample space on the top and bottom of the case for additional fans.

2 The Wraith Stealth is the smallest of AMD's stock CPU coolers, but it gets the job done in a low-cost system like this.

3 There's precious little space for cable management inside this case, but thankfully the front I/O can be used to hide away some of the excess cables.

4 The feet of the Q500L can be popped out and reattached to any side of the case for custom orientations.

Without Windows 10, this build would cost \$795, which we're pretty happy about. The 3200G performed above expectations; in fact, we'd say it's the best-value CPU with integrated graphics on the market. Under \$150 for performance that can comfortably carry out normal work functions and even cope with light gaming strikes us as an excellent deal. We managed to get an average of 30fps in *Rise of the Tomb Raider* by running it at low graphical settings in 1080p; less demanding titles such as *Fortnite* or 2D indie games run smoothly in 1080p.

There are a few things we'd do differently. When it comes to

components, turn the page to see which parts we suggest upgrading. There were some challenges in the build process, too; using an ATX mobo was a tall order, as the Q500L case has an enormous lip around the internal edges once the window panel is removed. Were we to build it again, we'd consider installing the memory and cooler after the motherboard is mounted, as they add to the weight during installation, which makes things trickier. On the other hand, installing components inside this already cramped case would be harder than doing so outside – it's a trade-off, with no simple answer.

The complications caused by the

case, BIOS, and cable management meant that it took us longer than expected to fully assemble. The latter was a particular point of contention; the Corsair CX450 power supply had a large number of leftover cables to tidy up. A modular PSU is the obvious answer, but that would have added too much to our total price, and doesn't solve the problem of excess cable lengths. Again, there's no easy solution; a bit more time spent routing cables will improve things, though, along with liberal use of cable ties. If you can get your hands on shorter SATA connector cables for the two drives, that'll help, too.

This system was conceptualised as a blank canvas, from which it can be shaped into whatever machine suits your needs. We think we've succeeded in creating such a PC; the potential here for this build to be upgraded and adapted to fulfill different purposes is significant. This system has two unused DIMMs, three unused PCIe x16 slots, two unused M.2 ports, and more. There's also room for more case fans, or a radiator for an AIO CPU cooler, and comfortable headroom for a larger air cooler on the CPU. This case can also be reconfigured to lay on its side, should you want to slot the finished PC into a space with minimal height clearance. In short, there's nothing this system can't do; what direction you take it is up to you.

BENCHMARK RESULTS

	ZERO-POINT	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	541	598 (11%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	540	562 (4%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	372	521 (40%)
RISE OF THE TOMB RAIDER (FPS)	5	15 (200%)
TOTAL WAR: WARHAMMER II (FPS)	3	10 (233%)
TOM CLANCY'S GHOST RECON WILDLANDS (FPS)	2	9 (350%)
3DMARK: FIRE STRIKE (INDEX)	1,183	2,642 (123%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i3-8100, 8GB of Team Vulcan DDR4 @ 2,400, and a 120GB Kingston SSDNow UV400. All tests were performed at 1080p at the highest graphical profile.

UPGRADE & IMPROVE

CPU

A simple upgrade for our CPU would be the Ryzen 5 3400G. At \$90 more, it provides double the threads of the 3200G, and an operating frequency of 100MHz faster (200MHz at maximum auto-overclocking). The 3400G also uses Radeon Vega 11 integrated graphics, as opposed to the 3200G's Vega 8. However, if we were to add a discrete GPU, it might be worth investing in a more powerful CPU without integrated graphics, such as the Ryzen 5 3600 or Ryzen 7 3700X. As a rule of thumb, select a 3000-series Ryzen CPU comparable in price to your graphics card.



UPGRADE

MOTHERBOARD

The most obvious upgrade here would be directly to an X570 motherboard, although, of course, this will come with an associated increase in cost. Cheaper X570 motherboards start at around \$270, although we would recommend upgrading to a slightly better model, such as MSI's MPG X570 Gaming Edge WiFi or Asus's TUF Gaming X570-Plus. The X570 format allows for PCIe 4.0, making Gen4 M.2 drives a possibility.



UPGRADE

PSU

The logical choice here is to go modular. The ability to simply remove unused power cables would work wonders for a cramped build like this, both in ease of assembly and in terms of aesthetics. There are plenty of good options, but our recommendation would likely be the Corsair RM550x, which provides fully modular power delivery for around \$145. Of course, if you're planning on throwing a GPU (or any other major components) into this build, you're going to need more power. 600W is perfectly sufficient for most systems that include a GPU, with 700W providing total peace of mind. Most importantly, make sure that the power supply you choose is small enough to comfortably fit the mounting bracket in the Q500L.



UPGRADE

STORAGE

There's plenty to choose from when it comes to system storage, but one of the key things missing from this system is an M.2 drive, due to their significantly higher price compared to SATA SSDs. There's potential to improve our SATA storage here; a single extra 2.5-inch SSD could be added without needing to change anything else, or we could forgo the HDD and replace it with two more SSDs. 1.5TB of storage is already respectable, though, so more speed might be a better direction to look in. Team Group, Western Digital, and Patriot all produce affordable Gen3 M.2 SSDs, or if you're looking for a higher-quality piece, Samsung and XPG are the way to go. Remember that upgrading to an X570 motherboard will be necessary if you want to use a Gen4 M.2 drive.

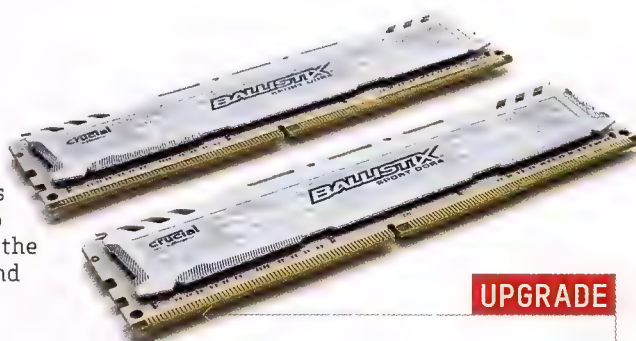


UPGRADE

GPU

A graphics card would be the biggest key addition to this build. There's a myriad of potential options out there, but unless you're upgrading the CPU as well, it's best to stick with a relatively conservative choice. A Radeon RX 580 or 570 from AMD would serve this build well, or a GeForce GTX 1650 from Nvidia. If you are

inclined to upgrade the processor, though, the sky's the limit; currently, our top GPU recommendations are the GeForce RTX 2070 Super and 2080 Super, both excellent cards for 1080p and 1440p gaming. The Radeon RX 5700 XT also gets an honorable mention here, currently one of the best AMD GPUs available.



UPGRADE

MEMORY

16GB was generous for this build, which could run with 8GB or even 4GB. We stand by our decision, though; the increased capacity means this rig is better equipped to support CPU or GPU upgrades.

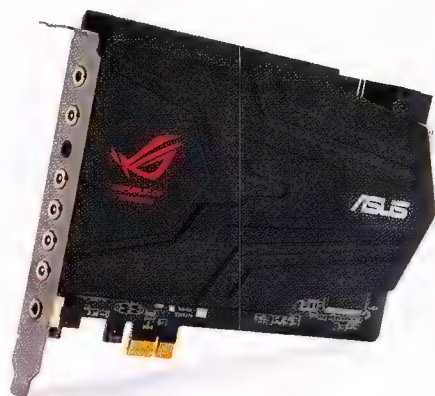
There's still potential for expansion, mind you. Upgrading to 32GB would be overkill unless you completely overhaul this PC's internals, but as we're using an AMD CPU, improved memory speed will make a reasonable difference. An upgrade to Corsair's DDR4-3000 Vengeance LPX makes sense – G.Skill, Ballistix, and T-Force all have quality offerings in the 3000-3600MHz range, too.

UPGRADE

UPGRADE

OTHER

Of course, there are more esoteric components you could add. If music or video editing is your thing, a soundcard may be a worthy addition, or a capture card if streaming is what you plan to do. Additional case fans are a possibility, too, and potentially a valuable addition if you're looking to overclock anything. Lastly, we'll turn our eyes to aesthetics: lighting. The pronounced lip around the rim of the Q500L's mobo cavity is the perfect place to position sticky LED strips, and with the right screws, an RGB controller can be anchored to the inside of the case, thanks to the perforated metal design.



COOLER

In all honesty, the cooler is the last part of this build that needs upgrading. For low-intensity tasks, the Wraith Stealth provides all the heat management you'll need, and upgrading the CPU will provide you with another packaged AMD cooler (such as the Wraith Spire or Wraith Prism). If you're looking to go further, the Q500L can support up to 240mm of radiator space for an AIO cooler. Cooler Master has plenty of offerings in this arena, which are practically guaranteed to be compatible. Corsair and Enermax also have affordable AIO cooling solutions. Unless you're looking to overclock, 120mm of radiator space should be sufficient for most CPUs. ■



System News

Mark Williams checks in to see if the DRAM shortage is finally over.

We last looked at DRAM prices back at the end of 2018. That was at the peak of the DRAM shortage, during the period when Samsung and Micron were both having teething problems ramping 18nm and 17nm production node rollouts for their memory divisions.

This created a shortage of DRAM in the market, which the only other major memory maker in the market, SK Hynix, couldn't take advantage of, ultimately meaning less stock and thus higher prices. Checking in almost a year later it is quite obvious that the DRAM shortage is well and truly over.

We took a snapshot back in May this year of some basic DRAM kits available and their prices at the time during the peak, which seemed to last a little longer than everyone was expecting. Back then, a 2x8GB kit of 2133MHz, 2400MHz and 3000MHz DDR4 memory cost \$139, \$149 and \$159 respectively. This very compressed price range was likely due to the more common slower speeds (and thus higher volume parts) starting to feel the pinch of the shortage, bringing them right up against the price of the higher tier kits. A rather crazy time when you look back at it.

At the time of writing, those same kits are respectively now \$75, \$109 and \$119, a massive 46%, 27% and 25% reduction in prices! And while those reductions are great, as Jaimie points

out in Shop Talk, the Australian dollar has fallen a little against the US dollar in that time, making these kits slightly more expensive than what they could've been had the market remained steady.

All this of course means cheap DRAM is once again available to everyone, including system integrators and builders. When asked if these price drops meant any changes generally for system builds now that the DRAM shortage is over, Jaimie said "Our standard speeds in a normal build has increased from 2400MHz to 2666MHz now, and gaming systems start from 3000MHz and are generally RGB".

While 2666MHz doesn't sound exciting, it's a big move when you're talking mainstream high-volume parts, not to mention around this time last year 2666MHz was still quite popular in entry level gaming rigs. So, while DRAM capacity usage has still largely stayed the same, speeds have at least moved on and become cheaper and more accessible.

AMD with its Ryzen 3000 series line-up has been pushing hard and making the case for the faster take-up of higher speed memory to best extract the most performance out of those processors. With the Threadripper 3000 series about to drop with quad channel memory

support, the thirst for fast DRAM will continue, but at least now it shouldn't cost an arm and a leg to fill all those memory channels.

Now, if only AMD could also bring some serious competition to the top end of the graphics card stack once again to bring down the prices of top tier cards from their current dizzying heights.

SHOP TALK

During this year, how much have you seen prices of DDR4 come down by on average? Has this affected what your customers now buy and what you sell in pre-built systems?

Jaimie, Leader Computers:

"We have seen DRAM prices pretty much halve since Christmas last year, which has helped combat the overall price hikes caused by a poorly performing Aussie dollar.

The specs have not really changed for our builds, with 8GB still being the entry- and mid-range norm, but it's a very popular upgrade to our systems due to the attractive performance boost jumping to 16GB for the relatively small cost.

The rise of RGB gaming memory has also helped to spur on the different manufacturers in their race to gain market share, keeping costs low and coming out with increasingly extravagant RGB lighting arrays. As is always the case in this industry, competition is good for the consumer!"

John, TI Computers:

"Yes, the DRAM price went up and down this year a few times, but that is more to the DIY consumers. We generally stock a good few months' supply of DRAM to prevent the fluctuation from impacting our business. Considering the cost of DRAM is also no longer the major contributor toward the overall cost of a desktop system, we don't really see much impact from the fluctuation of DRAM price this year."



Market Snapshot

A sampling of PC systems available this month.



TechFast Australia AMD Ryzen 5 3600 | GTX 1660 Ti 6GB

\$1,139 - [TINYURL.COM/APC475TFA](https://tinyurl.com/APC475TFA)

The diminutive small form factor used by this system means this isn't an imposing gaming rig like typical full-sized cases can seem to be on your desktop. While the headline parts in the CPU and GPU are very nice for any 1080p gaming scenario, this system is built to a bare minimum price and as a result compromises in all other areas.

The aging A320M chipset motherboard means no overclocking opportunities and limited IO options, like USB3.1 ports. The single RAM stick will result in some lost potential performance from lack of dual-channel memory, and the SATA SSD, while ok, isn't capacious enough to simultaneously install many of today's big modern titles at once. If you're on a budget, this packs in a lot of performance, just be aware of its shortcomings.

KEY SPECS: CPU: AMD Ryzen 5 3600, **COOLER:** OEM, **MOTHERBOARD:** Biostar A320M-based, **GRAPHICS:** GeForce GTX 1660 Ti 6GB, **MEMORY:** 8GB DDR4 2400MHz, **STORAGE:** 240GB 2.5-in SATA SSD, **POWER SUPPLY:** Allied 550W, **CASE:** TechFast Leaper SFF.



PC Case Gear Fusion 1660 Ti

\$1,699 - [TINYURL.COM/APC475PCC](https://tinyurl.com/APC475PCC)

On the other end of the 1080p spectrum, this PC goes mostly all out on the features and capabilities compared to the TechFast system this month. The motherboard is much friendlier for expansion, included IO and even has RGB to help show off your system. The NVMe SSD is what we'd consider the bare minimum these days, however its snappy speeds and the included 2TB HDD means you won't be wanting for storage space. The twin RGB memory sticks afford the CPU that dual-channel memory goodness at a higher speed than Ryzen's love. The Phanteks case and PSU round out this high-quality build.

While pricey, this is a good system to upgrade over time.

KEY SPECS: CPU: AMD Ryzen 5 3600, **COOLER:** OEM, **MOTHERBOARD:** Asrock B450M Steel Legend, **GRAPHICS:** Asus GeForce GTX 1660 Ti Dual OC 6GB, **MEMORY:** Team T-Force Delta RGB 3200MHz 16GB, **STORAGE:** Adata XPG SX8200 Pro M.2 NVMe SSD 256GB, Seagate Barracuda 2TB HDD, **POWER SUPPLY:** Phanteks PH-P550GF 550W, **CASE:** Phanteks Eclipse P360X RGB.



Scorptec Tundra RTX 2070 Super

\$2,999 - [TINYURL.COM/APC465SCP](https://tinyurl.com/APC465SCP)

This very white build from Scorptec helps accentuate the colours from all the RGB lighting used in this build to stunning effect. Equally stunning is the price to performance metrics of this build. As with all good builds in this category it utilises a CPU and GPU combo that are just a step or two down from the best. Here the 9700KF is always fantastic for high FPS gaming, you only miss out on an IGP. The RTX 2070 Super nets you RTX 2080 speeds. Good for 1080p 240Hz or 1440p 144Hz+ gaming in eSports titles. A beauty on the inside and the outside, this rig will please most serious gamers.

KEY SPECS: CPU: Intel Core i7 9700KF, **COOLER:** Corsair Hydro H100i RGB Platinum SE White, **MOTHERBOARD:** Asus Prime Z390-A, **GRAPHICS:** Gigabyte Gaming White GeForce RTX 2070 Super OC 8GB, **MEMORY:** Corsair Vengeance RGB Pro White 16GB 3000MHz DDR4, **STORAGE:** Kingston A2000 500GB M.2 SSD, Seagate BarraCuda 2TB HDD, **POWER SUPPLY:** Corsair Vengeance 650M 650W, **CASE:** Corsair Crystal 465X White.

JW Computers GMR Carbide 2080 Super

\$2,949 - [TINYURL.COM/APC475JWC](https://tinyurl.com/APC475JWC)

This is quite a serious build. Lots of CPU threads and the second-best GPU available, what more could you ask for?

Well, a cheaper price, unsurprisingly. The 3800X is a great CPU, but not for \$80 extra for about 5% extra performance over a 3700X. Then there's the motherboard, it's great but wasted with the SSD not being a PCIe 4.0 product to take advantage of the X570 chipset. It affords some future-proofing down the track for upgrades of course, but you're paying for it. These two things alone make this system over \$200 more than it needed to be for equal performance – savings which could have gone into including a watercooler and faster RAM instead. A great system, but a missed opportunity for a better deal.

KEY SPECS: CPU: AMD Ryzen 7 3800X, **COOLER:** OEM, **MOTHERBOARD:** Asus Prime X570-P, **GRAPHICS:** MSI RTX2080S Super Ventus XS 8GB, **MEMORY:** Kingston Fury 16GB (2x8GB) DDR4 3200Mhz, **STORAGE:** Kingston 500GB A2000 M.2 NVMe SSD, **POWER SUPPLY:** CoolerMaster MWE 650W, **CASE:** Corsair Spec-06 White with Deepcool RF120M RGB fans.



PC blueprints

The APC team's picks for a part-by-part perfect PC build to suit your budget.



PARTS LIST

PART		PRICE
CASE	BITFENIX NOVA TG	\$55
PSU	CORSAIR CX450 80+ WHITE 450W NEW	\$75
M/BOARD	ASROCK B450M R4.0 AM4	\$95
CPU	AMD RYZEN 5 2600	\$199
GPU	GIGABYTE GEFORCE GTX 1660 OC 6GB	\$359
RAM	8GB (2X 4GB) PATRIOT VIPER 4 @ 3,000MHZ NEW	\$65
SSD	120GB CRUCIAL BX500 2.5-INCH	\$29
HDD	1TB WD BLUE 3.5-INCH HDD	\$59
OS	UBUNTU DESKTOP LINUX 18.04 LTS 64-BIT	\$0

APPROXIMATE PRICE: \$936

If you're assembling a budget gaming PC, grab a Ryzen 5 2600 right away. Not only is it a great deal for a paltry \$120, but it comes packaged with three months of Xbox Game Pass on PC, which includes access to recent releases such as *Gears 5*, *Blair Witch*, and *Metro Exodus*. We've made some small savings elsewhere in this build, too. Price fluctuations in 8GB memory kits spurred us to head back to America and trade our Team T-Force RAM for the Patriot Viper 4 kit – functionally identical with the same latencies and speed, but a few dollars cheaper. Lastly, the Corsair VS450 is becoming hard to find, but the CX450 is – a simple enough swap to keep our price down. We made a small saving of \$12 dollars against last month, with minimal change in performance.

PARTS LIST

PART		PRICE
CASE	FRACTAL DESIGN MESHIFY C	\$149
PSU	500W COOLER MASTER MSW SILENCIO 80+ BRONZE	\$55
M/BOARD	MSI MPG X570 GAMING PLUS NEW	\$299
CPU	AMD RYZEN 5 3600X	\$385
COOLER	AMD WRAITH SPIRE	N/A
GPU	SAPPHIRE RADEON RX 5700 8GB	\$699
RAM	16GB (2X 8GB) G.SKILL RIPJAWS V @ 3,200MHZ NEW	\$129
SSD	250GB SAMSUNG 970 EVO PLUS M.2 PCIE	\$75
HDD	1TB WD BLUE 3.5-INCH HDD	\$59
OS	WINDOWS 10 HOME 64-BIT OEM	\$140

APPROXIMATE PRICE: \$1,990

AMD is killing it with the game deals right now. There's no price drop this month on the Ryzen 5 3600X, but orders now come with a copy of either *Borderlands 3* or *The Outer Worlds*, both great new titles. Sapphire's Radeon RX 5700 has some deals tied to it, too, including Xbox Game Pass and *Ghost Recon: Breakpoint*. It's also \$20 cheaper than last month, which frees up a bit of cash for us to play around with. The first order of business was to upgrade the motherboard, because last month we chose the most budget X570 mobo we could find. This time around, we're going with MSI's MPG X570 Gaming Plus, an extra \$10 netting us a heat shield for the M.2 drive. A slight price rise for the previous Corsair memory kit was enough to persuade us to switch it out, but we did replace the memory, going for G.Skill's Ripjaws V series this month.



UPGRADE OF THE MONTH

MSI MPG X570 Gaming Plus

\$299, WWW.MSI.COM

Yes, it does look as though it was designed by Reaper from *Overwatch*. That's OK, though; at just \$170, the MPG X570 Gaming Plus delivers a lot of high-end motherboard features, from M.2 heat shielding to server-grade PCB, and intelligent power delivery systems. It's the perfect accompaniment to a mid-range Ryzen 3000 chip, such as the 3600X, provided you can look past the black and red design. A tricked-out rear I/O, including HDMI for integrated graphics and a gen-3.2 USB-C port, is just the perfect cherry on top. MSI also happens to be one of our favorites when it comes to straightforward BIOS UIs, so that's a bonus, too!

"With both Ryzen and Threadripper 3000 CPUs packing PCIe 4.0, high-speed Gen4 NVMe SSDs will soon be on the menu. For now, we're still making a change, taking the savings from the memory to upgrade our storage from 512GB to 1TB."

There's a lot going on in the high-end desktop CPU arena. AMD's 16-core Ryzen 9 3950X is set to replace second-gen Threadrippers, while the third gen of Threadripper chips is hot on its heels, too. By the time you read this, those chips may well be available; watch this space, because we might finally be swapping out the trusty 2950X.

We nevertheless looked to make improvements here and there. First up was memory, and while we stuck with G.Skill, we're going for a 3,600MHz kit of Sniper X instead of last month's 3,200MHz kit, and it was \$60 cheaper too. Then we splashed out on a new cooler, going for Corsair's Hydro H100i. This should add more flair, as our previous Fractal Design cooler lacked the H100i's RGB effects.

Our SSD will likely see a big upgrade in the not-too-distant future, too. With both Ryzen and Threadripper 3000 CPUs packing PCIe 4.0, high-speed Gen4 NVMe SSDs will soon be on the menu. For now, we're still making a change, taking the savings from the memory to upgrade our storage from 512GB to 1TB. This comes with a caveat: a shift from Samsung's Pro line to the Evo series, which will have a small impact on overall drive performance. It's a worthy trade-off for doubling our primary drive capacity, though. ■

PARTS LIST

PART		PRICE
CASE	NZXT H700I	\$219
PSU	850W CORSAIR TX-M SERIES 80+ GOLD	\$179
MOBO	ASROCK X399 PHANTOM GAMING 6	\$419
CPU	AMD THREADRIPPER 2950X	\$1,179
COOLER	CORSAIR HYDRO H100I RGB PLATINUM 240MM AIO NEW	\$229
GPU	EVGA GEFORCE RTX 2070 SUPER BLACK GAMING 8GB	\$889
RAM	32GB (2X 16GB) G.SKILL SNIPER X @ 3,600MHZ NEW	\$239
SSD	1TB SAMSUNG 970 EVO M.2 NVME NEW	\$309
HDD	2X 3TB SEAGATE BARRACUDA COMPUTE	\$360
OS	WINDOWS 10 HOME 64-BIT OEM	\$140
APPROXIMATE PRICE:		\$4,162

howto

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

WINDOWS

LOCAL ACCOUNTS IN WINDOWS

With the recently released 1903 update, I decided to reinstall Windows from scratch. During the setup process I was only given the option to create a Microsoft Account using an email address. Has the option to create a local account on a PC been scrapped?

Jay Derbyshire

The local option is still present in the 1903 update, and in fact is slightly easier to find now – when prompted to create an account, click 'Offline account' followed by 'No'. Some PC manufacturers have hidden the option during the setup process – if you can't find it, restart the setup process while disconnected from the internet to hopefully force it into view.

Similarly, the option for creating new local user accounts in Windows itself is buried deep: head to 'Settings > Accounts > Family & other users', opt to

create another account and then click 'I don't have this person's sign-in information' followed by 'Add a user without a Microsoft account'. It's also worth remembering that attempting to sign into certain Microsoft services – such as downloading apps from the App Store – can lead to local accounts being converted to Microsoft ones. If this happens, you can try converting it back again via Settings > Accounts > Your info – click 'Sign in with a local account instead' and follow the prompts. We recommend taking a drive image before you attempt to convert it

back – just in case something goes wrong.

Ian Sleightholm

EMAIL

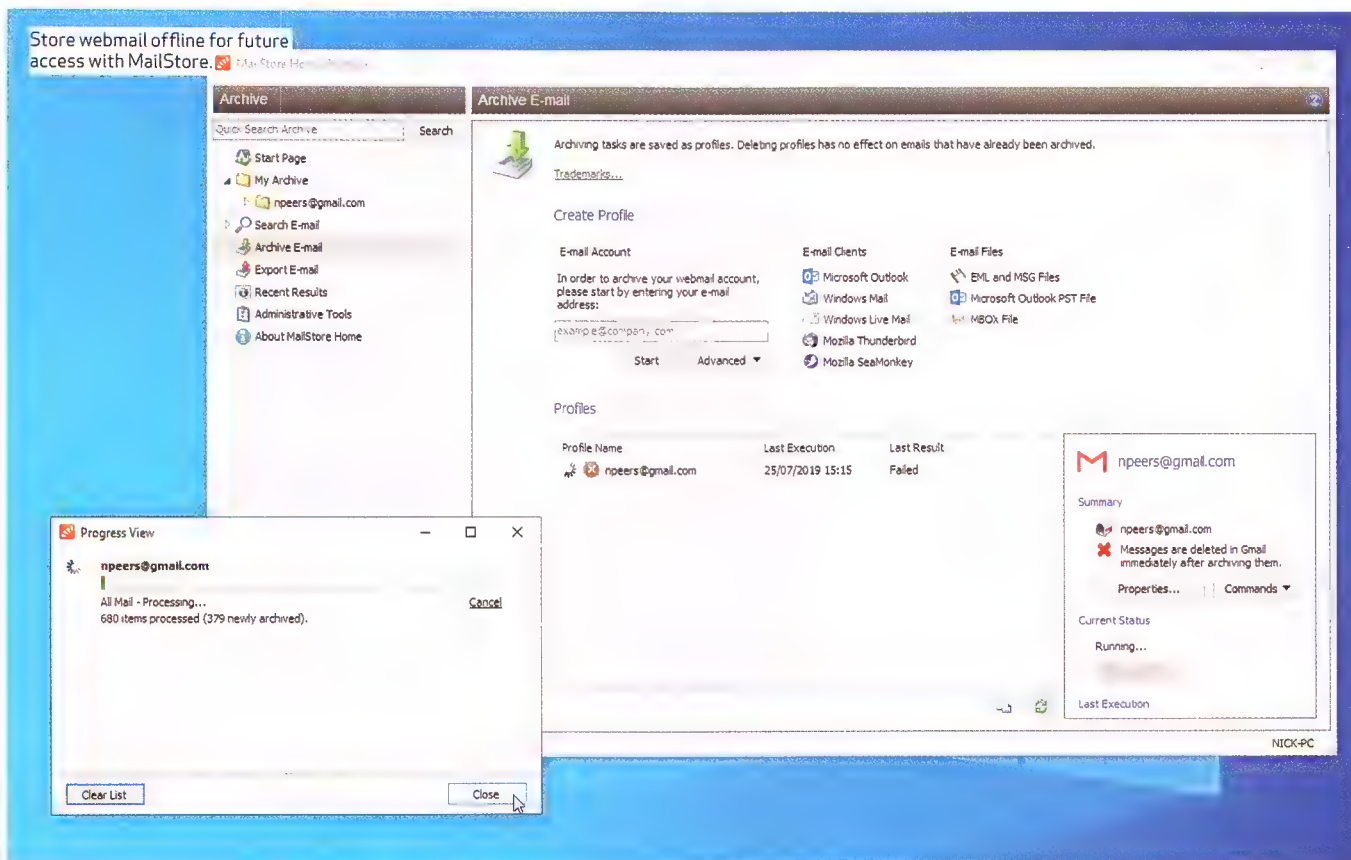
ARCHIVE GMAIL OFFLINE

I'm running out of space in my Google account and realise I've got thousands of Gmail messages clogging up the system. Rather than deleting them all manually, is there some way I can back up them up offline and then delete them to free up space?

Andrew Parkhurst

"attempting to sign into certain Microsoft services can lead to local accounts being converted to Microsoft ones."





The solution lies in downloading and running MailStore Home (www.mailstore.com), a portable tool designed to archive email from a variety of email clients and online sources, including Gmail. After opening it for the first time, choose Archive E-mail and follow the prompts depending on your webmail address or email client. We recommend choosing to archive – and delete – all messages before a certain date. After you’ve run the task for the first time, you’ll be able to browse and search your archive for emails using the tools supplied, plus restore them to Gmail if the need arises. Be sure to add the MailStore folder, which contains your downloaded emails, to your backup.

Catherine Ellis

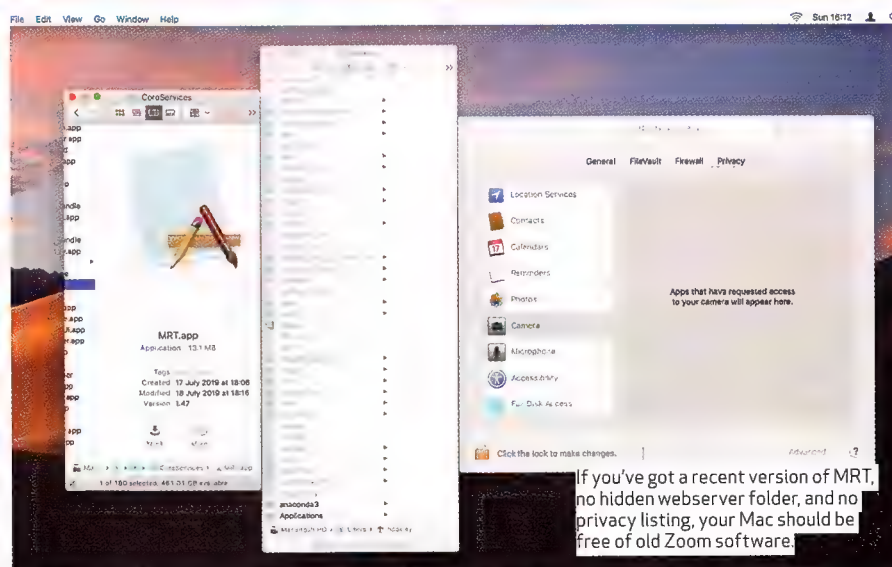
SECURITY

HOW DO I CHECK THAT MY MAC IS NOW SAFE FROM ZOOM?

I had the old vulnerable Zoom software installed. My Mac has now been updated to remove it. How can I be sure that it's worked?

Tom Marchwood

Older releases of conferencing software supplied by Zoom and partners installed a web server in a hidden folder inside your Home folder. This proved a serious vulnerability, as it's left behind even when the main app's removed. Apple



pushed three software updates to its Malware Removal Tool MRT to remove these. First check the version of MRT currently installed, either using a utility like my free SilentKnight from bit.ly/mf344silkn, or by selecting the app at /System/Library/CoreServices/MRT.app in the Finder. It must be version 1.47 or later. Reveal hidden items in the Finder by pressing command-up arrow-, then select your Home folder in the sidebar, and look for a folder named .zoomus. Some methods of removing the web server replace it with a file of that name, and lock its permissions to prevent the folder from being reinstalled, so if you find a file of

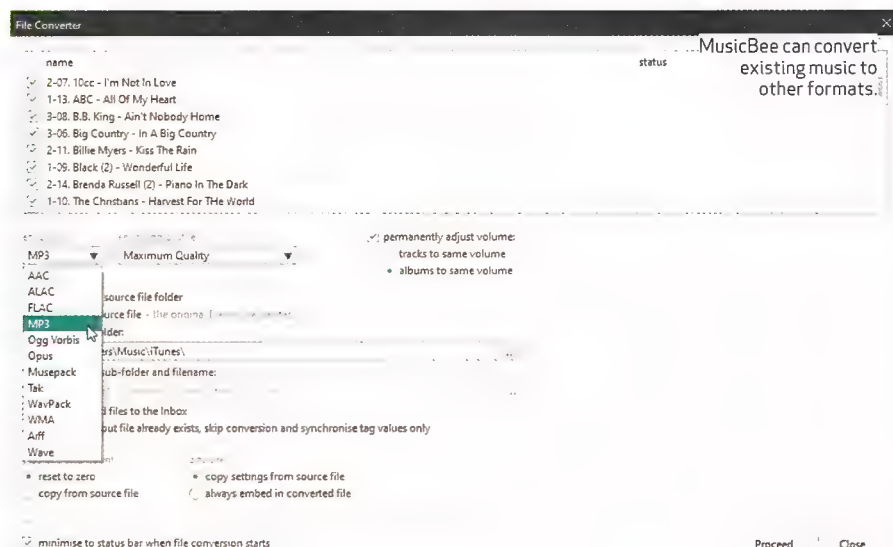
that name don't remove it. To remove it from Microphone and Camera lists in the Privacy tab of your Security & Privacy pane, install the current app (without a web server), untick it in those lists, then use the app's uninstall command in the File menu to remove it again.

Howard Oakley

RECOVERY

RECOVER FILES FROM DELETED USER ACCOUNT

After creating a new user account to fix a problem, I chose to delete my original user account, selecting 'Yes' when prompted to keep my files, being told they would appear



my vehicle. I want to see the exact same design, background and playlist as though I were playing a CD in VLC on my PC. I need each CD to show up separately, so the tracks aren't jumbled together. How can I do this?

Gerald Gibson

Gerald and his wife have two relatively new 4x4s, both of which have touchscreen displays and accept voice commands. With this in mind, the best approach to take when preparing music on a USB thumb drive is to stick to some universal rules that should work across these and other similar vehicles. For use in a car, format the USB thumb drive in FAT32 format, and avoid using sticks that are larger than 32GB – Windows doesn't like formatting larger drives to FAT32, and the cars might not read them. Second, check your owner's manual for compatible file formats. If in doubt, be sure to rip your CDs to MP3 format. If your files are already in another format, use MusicBee's conversion tool (browse to the parent folder, then select MusicBee > Tools > Convert Format to convert to MP3). Voice commands also rely on music files being correctly 'tagged' with metadata – Windows Media Player and MusicBee should add this while ripping, but you can verify and edit metadata using MP3Tag (www.mp3tag.de/en/) if necessary.

Nick Peers

HARDWARE VIRTUAL MACHINE HARDWARE UPGRADES

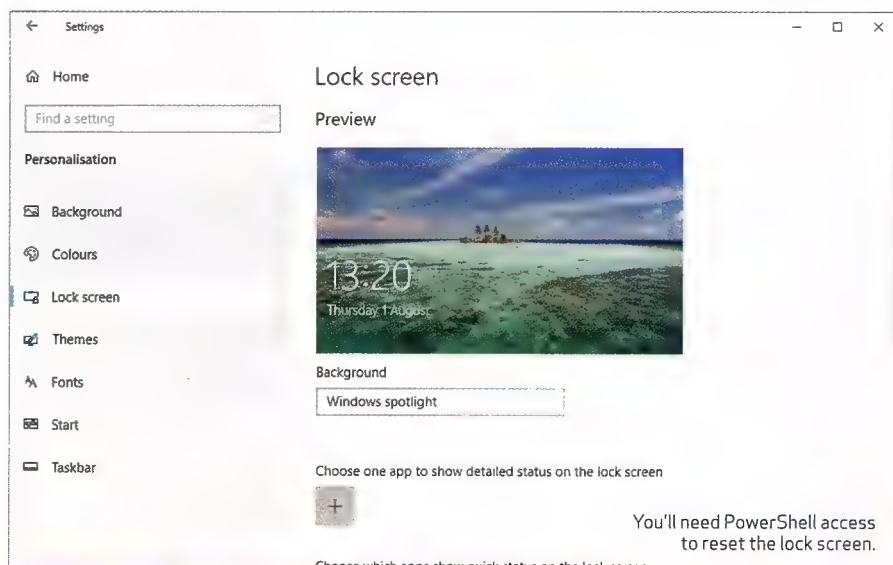
I'm looking to purchase or upgrade my PC specifically for the purposes of running a couple of virtual machines so I can continue to run older applications. What sort of hardware spec should I be looking for?

Pete Stuart

There are three critical components: processor, RAM and storage. Look for a processor offering at least six cores, such as the latest AMD Ryzen 5 or Intel Core i5. If your budget stretches to around \$500, look at the AMD Ryzen 7 3700X chip, which offers eight cores – enough to run two dual-core virtual machines while retaining four cores for your main Windows installation. When it comes to RAM, install as much as you can afford: 16GB would give 4GB to each virtual machine while reserving 8GB for your main PC, but 32GB would obviously double those figures.

Finally, purchase SSD storage (512GB can be had for under \$120) to ensure your VMs can run at maximum speed.

Mayank Sharma



"When it comes to RAM, install as much as you can afford: 16GB would give 4GB to each virtual machine while reserving 8GB for your main PC."

as a folder on my desktop. My laptop then froze – after 30 minutes I rebooted, but the files weren't on the desktop and the original account has gone. How do I recover my files?

Tom Hunter

It's never wise to delete a user account without having backed up its files first – for the reason you've just encountered. Your chances of recovering all of your lost files are slim, but you may be able to get some back. Download the portable version of Recuva from www.ccleaner.com/recuva/builds to anywhere but your system drive (a USB drive will suffice)

to avoid writing to the system disk. Run this and follow the wizard to try and locate (and recover) the missing files – perform a slower, but more thorough, deep scan to maximise your chances of successful recovery.

Carrie Marshall

HARDWARE USB MUSIC FOR THE CAR WITHOUT A CD PLAYER

Most new vehicles no longer have a CD player. My car has a USB port into which I'm supposed to plug in a media device, controlling it with the media/music app on the dash console. I have dozens of CDs I wish to rip to a thumb drive to play them in



Specific MacBook Pros running some versions of macOS have problems waking external displays.

MAC

SLEEPING WITH AN EXTERNAL DISPLAY

When my MacBook Pro sleeps connected to an external display, it has trouble waking up, sometimes requiring a restart. How can I fix this?

Duncan Brack

With any sleep problem like this, the first step is to reset the System Management Chip (SMC) and the Non-Volatile RAM (NVRAM, formerly PRAM). In many cases, that should restore normal function, but running some versions of macOS makes specific models prone to sleep and wake problems, particularly MacBook Pro models connected to external displays. This probably relates to the EFI firmware supplied with that release, and updating to the latest version can fix it. Apple now only provides those firmware updates as part of macOS and its security updates. There's a list of versions for recent models at bit.ly/mf344efi. Another cause is an incompatible kernel extension. Those are harder to address, though most third-party extensions should now be installed in /Library/Extensions – check through that for anything old and unneeded.

Howard Oakley

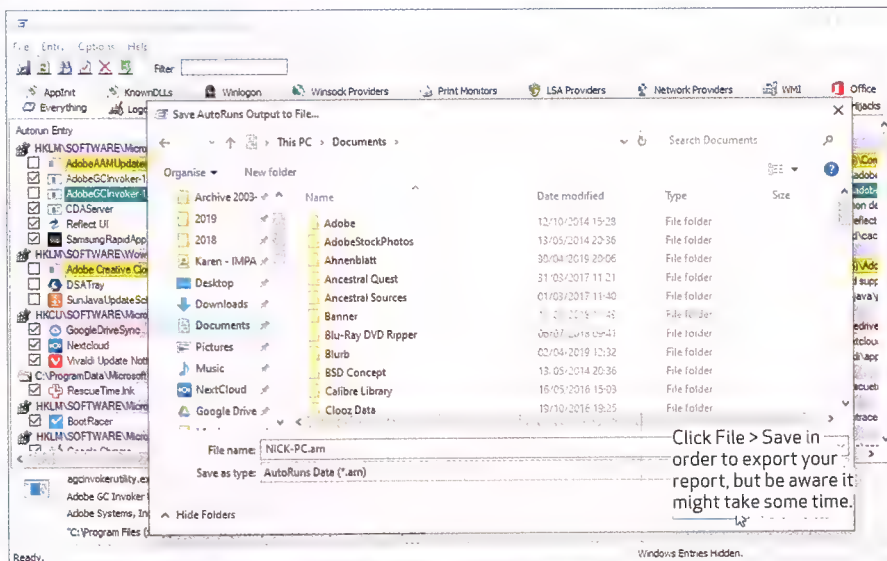
WINDOWS

WINDOWS SPOTLIGHT SCREEN STUCK

My Windows 10 laptop used to rotate the picture that showed on the lock screen on an occasional basis, but for the past few weeks it's been stuck on the same screen. How do I fix this?

Lena Howard

This could be down to several things – first, take a trip to Settings > Privacy > Background apps and confirm both Background Apps, and more specifically Settings, are both allowed to run in the



background. If this is the case, head over to Personalisation > Lock Screen and verify Windows Spotlight is selected under the Background drop-down menu. Assuming it is, type "powershell" into the Search box and click Run as administrator. Now type the following command – all on one line – and hit Enter:

```
Get-AppxPackage -allusers
*ContentDeliveryManager* |
foreach {Add-AppxPackage
"$($_.InstallLocation)\
appxmanifest.xml"
-DisableDevelopmentMode
-register }
```

This will reset Windows Spotlight. Restart and it should hopefully start working again.

Carrie Marshall

WINDOWS

SHARE YOUR PC START-UP ROUTINE WITH OTHERS

I believe a start-up item is causing my PC problems. How can I diagnose this with someone else's help?

Karen Fraser

Autoruns is our go-to tool for getting a complete overview of what's starting with your PC. You can also use it to compile a report when asking for assistance.

Download Autoruns from <https://bit.ly/autoruns>. After downloading, right-click Autoruns.zip and choose Extract All > Extract. The Autoruns folder will appear after the files are extracted. Double-click Autoruns64.exe.

Wait while Autoruns scans your system – this can take up to a minute or so. Once scanning is complete, switch to the Logon tab to get an overview of what starts with your PC. You can also disable or delete start-up items from here.

If you need to share your start-up entries then choose 'File > Save' to save a report to your Documents folder. Again this can take some time, so be patient. Once done, close Autoruns.

The uncompressed file is rather large – locate it, right-click and choose 'Send to > Compressed (zipped) folder'. Once done, open your email client and attach the zip file to your message asking for help.

Nick Peers ■

Set up a 4K display

Nick Peers shares how to configure and optimise your new UHD monitor for a sharper, readable display.

Ultra HD – also known as 4K – displays aren't just for gamers, media enthusiasts or graphics professionals. The ability to have three or four non-overlapping windows on-screen at once is beneficial even if you're just surfing the web or editing documents. And with prices now around \$400 for entry level models, there's never been a better time to upgrade your monitor to 4K.

Viewing such a high resolution – particularly on smaller (24 or 27-inch) monitors – can result in tiny text and icons, making things difficult to read. Thankfully, both Windows and your monitor manufacturer (we've used LG in this tutorial as an example) provide tools to help alleviate these issues, which is where we come in. Read on to discover how to set up your display to improve readability without sacrificing resolution.

PERFORM CALIBRATION

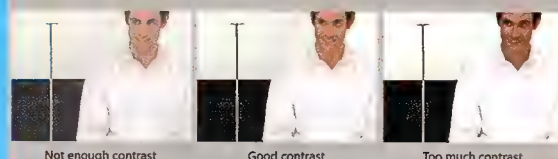
Open the display calibration tool to let it fine-tune colour balance, gamma and other settings.

Display Colour Calibration

How to adjust the contrast

The contrast adjustment determines the level and clarity of highlights.

When adjusting the contrast on the next page, try to get the image to look like the sample image labelled Good contrast below.



To continue, click Next.

Settings

Home

Find a setting

TWEAK SETTINGS

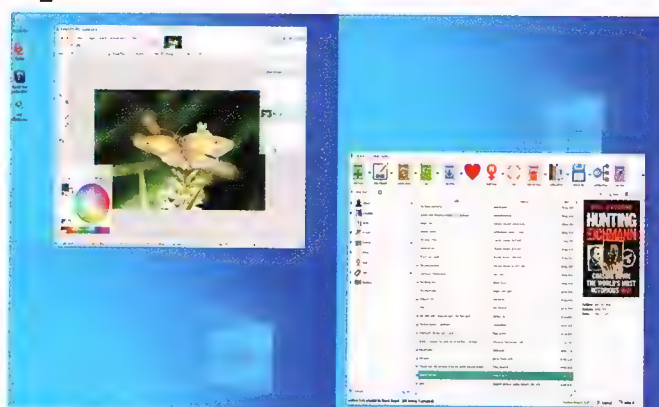
Not all apps scale properly – look for an update with 4K support, or see if you can zoom within the app.

Set up your new display



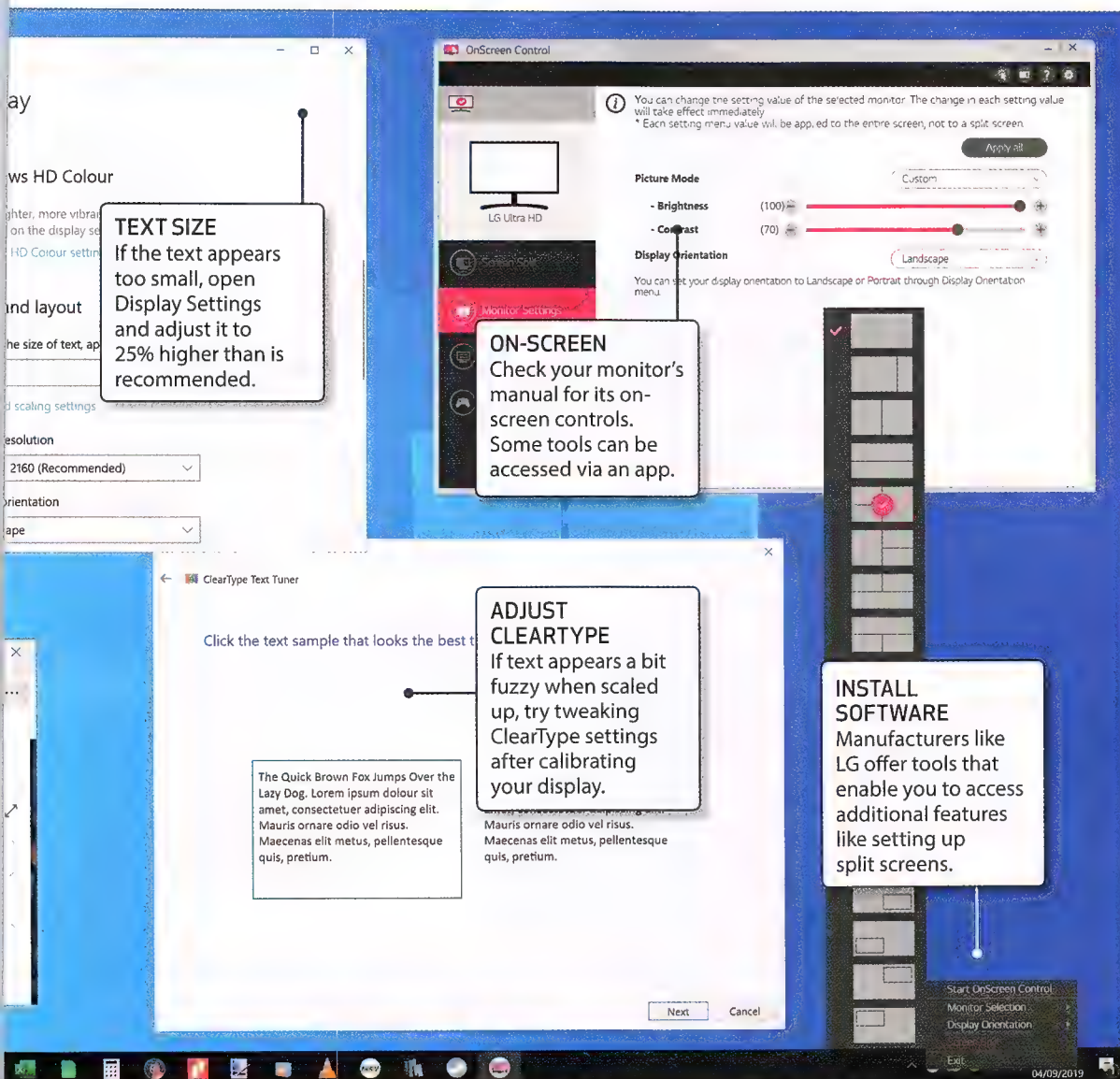
1 PICK THE RIGHT CABLE AND PORT

After placing your new monitor on your desk, you'll need to connect it to your PC. This may be a straightforward HDMI-to-HDMI cable, or you may find your PC only has a DVI port – in this case, verify it supports 4K (some lower end graphics adapters don't support 4K through the DVI port) before purchasing a HDMI-to-DVI cable or adapter – around \$5-\$10 online.



2 FIRST RUN

Switch on your PC and monitor. Consult your monitor's setup guide to see if you need to use the built-in controls – in most cases, the automatic settings should be in play, so it detects your PC automatically. Log into Windows when prompted: you should find the display has scaled automatically to 4K (3,840 x 2,160) – icons will be smaller, and text may be difficult to read.

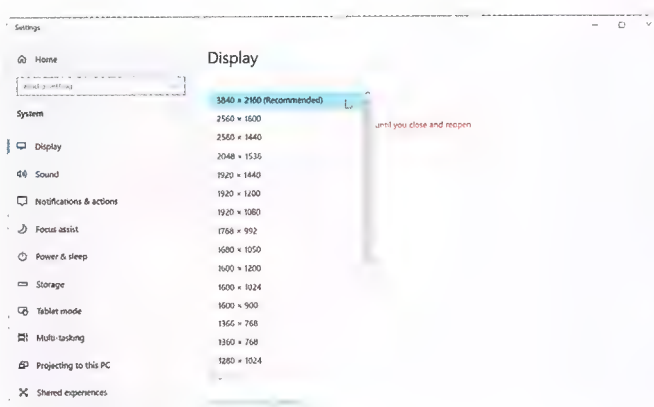


NICK'S BEST TIP
Look for a 'gaming mode' which will fine-tune your display to adapt to the specific needs of fast motion.

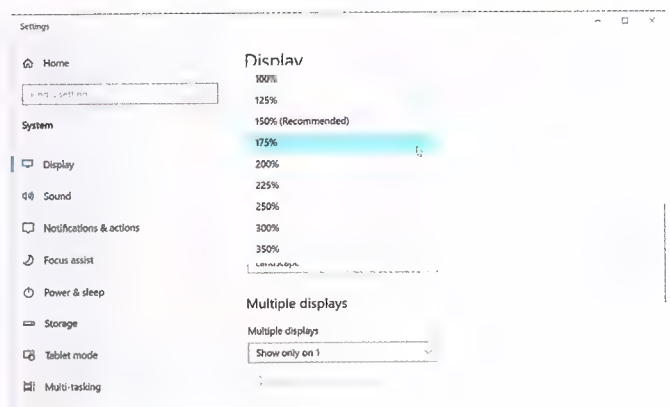
JARGON BUSTER!
4K
Refers to the monitor's horizontal display resolution of approximately 4,000 pixels (3,840 pixels in Ultra HD/4K).

DVI
Stands for Digital Visual Interface and is an alternative video port to HDMI. The principal difference is that DVI can only carry video signals; HDMI can carry audio too.

PRESET
A selection of pre-configured display settings, from brightness and contrast to colour balance, sharpness and black levels.



3 CONFIGURE SCREEN SETTINGS
Right-click some empty space on the desktop and choose 'Display settings'. Your new display should be listed as '1'. Make sure it's selected and scroll down to the 'Scale and Layout' section. Verify the 'Display Resolution' is set to 3,840 x 2,160 – if it's not, click the drop-down menu to select it from the list. The display should automatically update – click 'Keep changes'.



4 TWEAK TEXT SIZE
Believe it or not, the text may have already been made larger on-screen for Windows and compatible apps. On our LG 27in display, we still found things too small at the 150% setting, so click the 'Change the size of text, apps and other items' drop-down menu and try a higher setting. 25% more should be sufficient – any larger and incompatible apps become noticeable.



The screenshot shows the Oracle APEX application interface. On the left, there is a navigation menu with a red header bar containing the text "Oracle APEX". Below the header, there are several icons representing different application components. The main content area displays a list of server configurations. A red box highlights a row in the list, and a red '1' icon is placed next to it, indicating a specific record.

Select the display adapter on which you want to install the driver:

ATI ULTRA M1600 (ATI) Generic PNP Monitor

Select the driver you want to install:

ATI ULTRA M1600

OK Cancel

ATI ULTRA M1600 Properties

General Driver Details Events

ATI ULTRA M1600

Driver Provider: ATI

Driver Date: 21.08.2015

Driver Version: 8.0.0.0

Display Adapter: Microsoft Windows Hardware Compatibility Publisher

Driver Details: View details about the installed driver file

Update Driver: Locate the driver for this device

Roll Back Driver: If the device fails after installing the driver, roll back to the previously installed driver

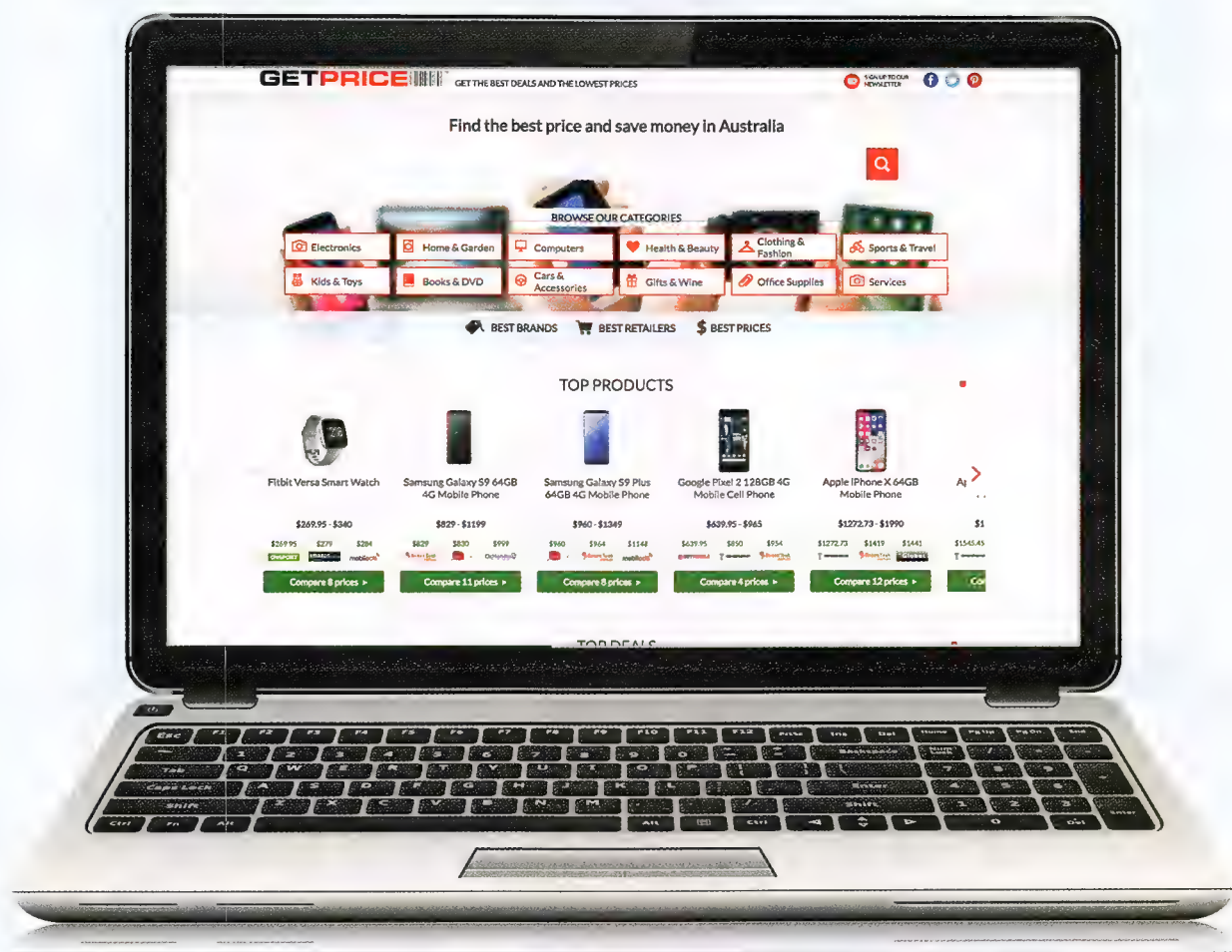
Disable Device: Disable the device

Uninstall Device: Uninstall the device from the system (Advanced)

OK Cancel

The screenshot shows the Axure RP application window. The title bar reads "Axure RP - My Application Preset". The interface includes a top toolbar with icons for file operations and a sidebar on the left with icons for "System Settings", "Project Settings", and "Project Assets". The main workspace is titled "My Application Preset" and contains a "Preview" section with a "Picture Mode" button. Below this, there are two columns of settings: "Application" and "Picture Mode". The "Application" column includes "Application Name", "Application Icon", "Application Color", "Application Font", and "Application Size". The "Picture Mode" column includes "Picture Mode", "Picture Color", "Picture Font", "Picture Size", and "Picture Background". The "Preview" section shows a wireframe of a mobile application interface with a header, a main content area, and a footer.

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on the latest tech.
www.getprice.com.au

GETPRICE  TM



Back up your iCloud photos

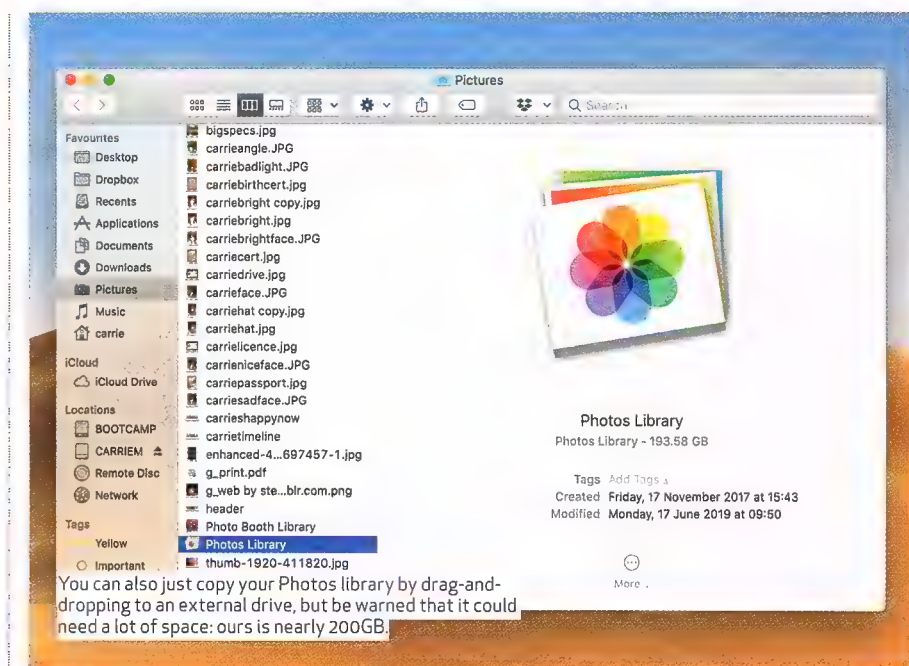
Protect your precious memories from digital disaster, with Carrie Marshall.

Storing photos in iCloud is a wonderful thing, but it isn't a backup. That's because of two things. One, if someone else gets your login details you're stuffed; and two, it's a single point of failure: if something goes wrong on iCloud, the problem could then be synced across all your devices. Not great when you're talking about priceless photos and videos.

Backups should be separate from your Mac, there should be more than one and you should back up regularly. If you're happy to back up manually, stick a recurring reminder in Calendar – but we'd recommend using a dedicated backup app, such as SuperDuper, and an external drive with a large storage capacity to ensure backups happen on time.

MIXED MEDIA

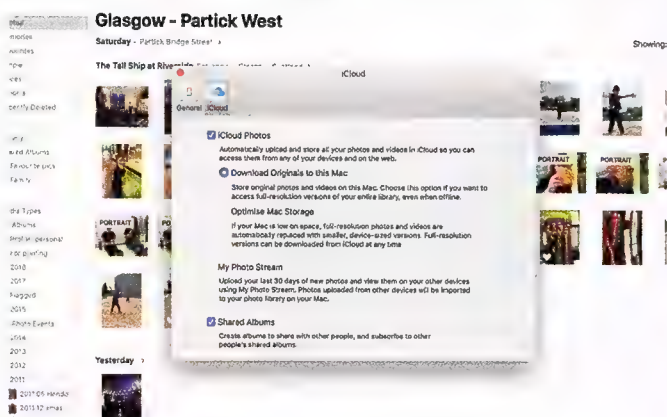
Think carefully about your choice of backup media. It's not just about storage space, as important as that is: for example, storing a 200GB Photos library on multiple rewritable DVDs would take forever and cost a fortune. It's about reliability and proximity too. Discs get scratched or



can rot, USB sticks often disappear to wherever odd socks and Biro's go, and an external drive or SSD that lives in your laptop case can be stolen or damaged alongside the computer.

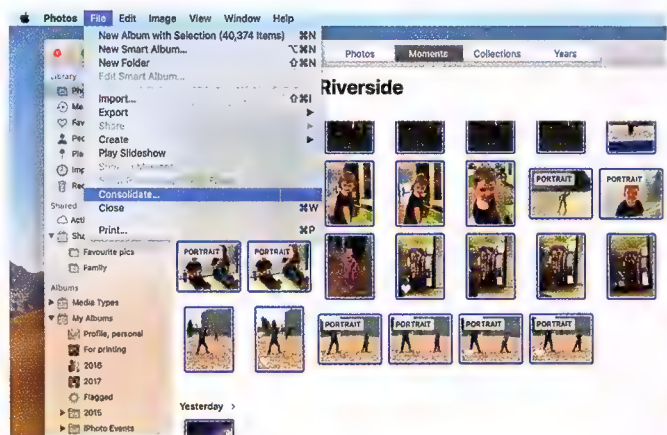
As the playwrights Norton and Sackville wrote back in 1565: "Hope for the best and prepare for the worst".

Make your photos fail-safe



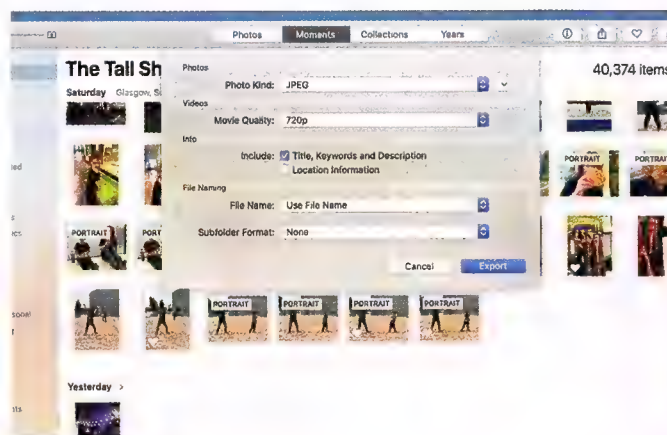
1 CHECK YOUR COLLECTION

You can't back up things you don't have, so go into Photos' Preferences and make sure that iCloud Photos > Download Originals to this Mac is checked in the iCloud tab or your Mac won't have all your images.



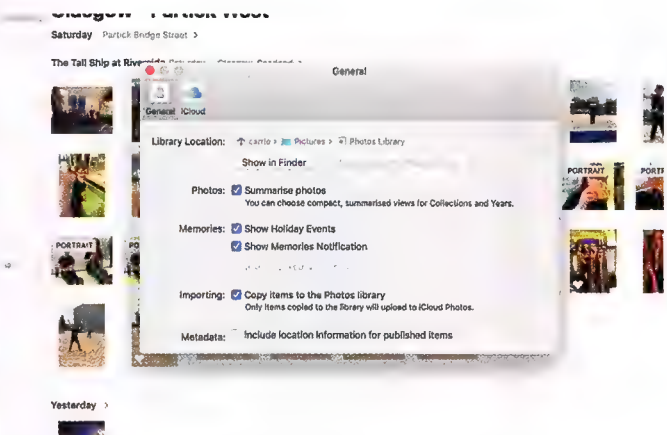
3 CONSOLIDATE THE LIBRARY

To copy any imported items that aren't stored in the Library, go to File > Consolidate. Photos will now look for any images that haven't been copied to the library, and will copy them across for you.



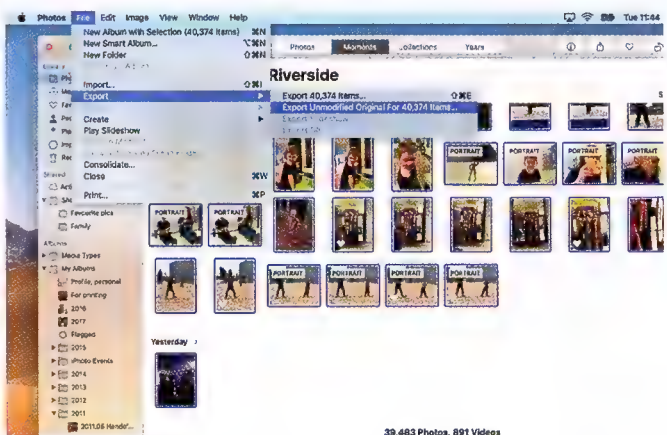
5 ADJUST THE SETTINGS

You can also modify the export settings, so for example you might want to use a subfolder for each Photos Moment, to replace photos' file names with titles or to export in JPG format for other devices.



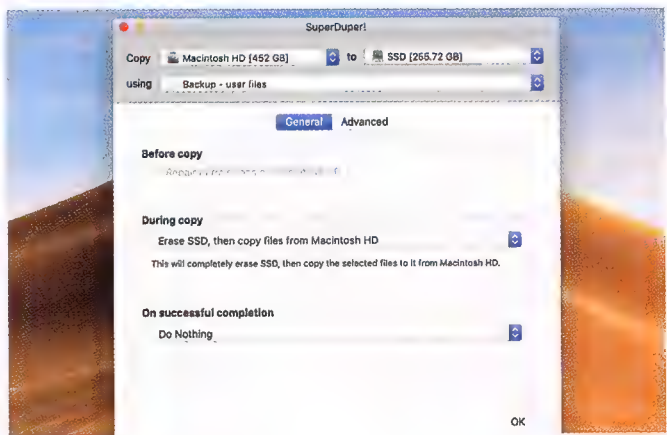
2 KEEP IT ORGANISED

Make sure 'Copy items to the Photos library' is selected in Preferences > General. If this isn't checked, photographs that you import from elsewhere on your Mac will remain in their original location.



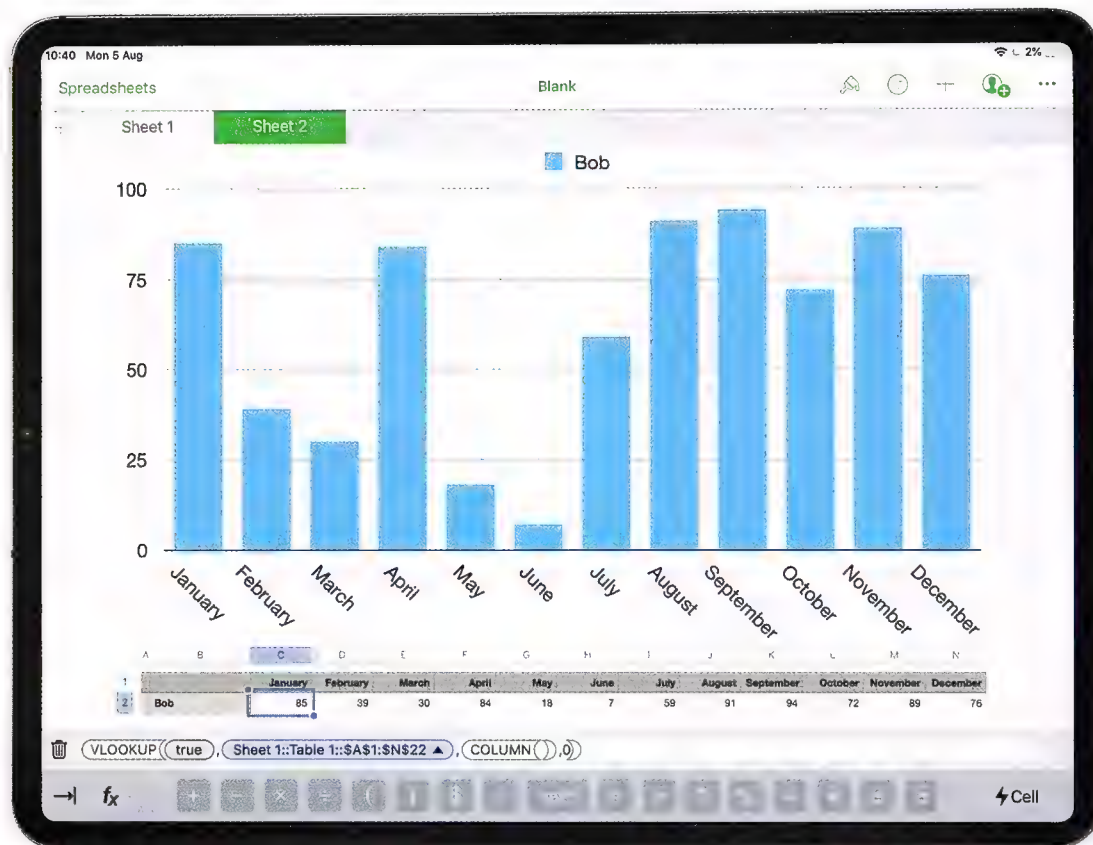
4 EXPORT YOUR IMAGES

If you have a large external drive you can simply select the images you want to back up and then select File > Export. Use the 'Export Unmodified Original' option to keep all of your images in their original unedited form.



6 DO IT REGULARLY

It's wise to include your Photos library in your standard backup routine. We recommend using external storage with a third-party backup app, such as the excellent SuperDuper, so you don't forget to back up.



Summary sheet in Numbers

Extract data from a table with some handy multi-purpose tricks, as Adam Banks demonstrates.

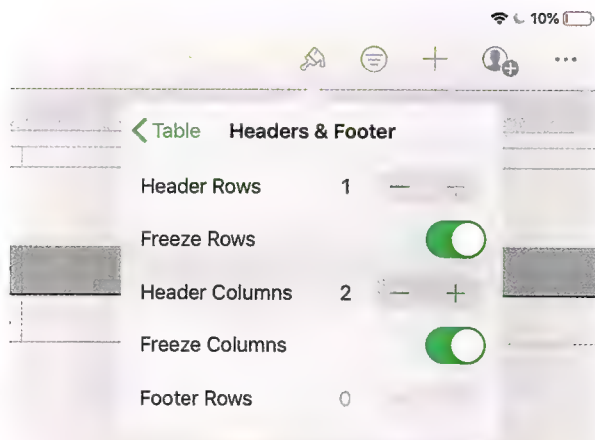
Summary sheets are commonly used to pull together information. In this example, we're pulling out a subset of data from a table rather than compiling a new table from multiple sources, using a table of scores for a set of participants in a monthly test. How can we show each participant's personal progress? Creating a separate table or sheet for every participant would mean a lot of manual duplication. Instead, we can make a single summary sheet that will update with the data for any participant we select.

We've used a separate sheet for two reasons: firstly, it's something you might want to print or export by itself; secondly, we can preserve a distinction between Sheet 1, which is only for entering data, and Sheet 2, which only outputs data. You could use the same techniques with a second table on Sheet 1, if you preferred, and you can always lock any table (Paintbrush > Arrange > Lock) to prevent editing.

LOOKING UP

The key function is VLOOKUP, which returns data from a row selected by searching the leftmost column of a range. We'll also use RANDBETWEEN to enter some dummy data, which is helpful if you're creating a template for entering data you don't have yet. Just select the cells and tap Delete to clear the table for real data when you have it.

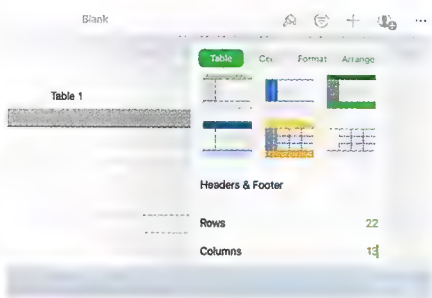
You could also add more data to the chart in Sheet 2, such as a line showing someone's average score so far or the average across all participants in each test.



Names in Sheet 2 appear in the second column – to still use these as your header, tap the formatting brush, go to Table > Headers & Footer and increase Header Columns to 2.

"How can we show each participant's personal progress? Creating a separate table or sheet for every participant would mean a lot of manual duplication."

Create a selective pull-out sheet



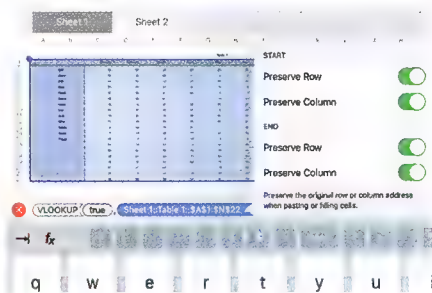
1 CREATE A SPREADSHEET

Open Numbers and tap Create Spreadsheet, then Blank. This creates a single sheet with one table. Unlike in Excel, you don't get infinite cells. Tap the formatting brush, then Table to set the size – here it's 13 columns.



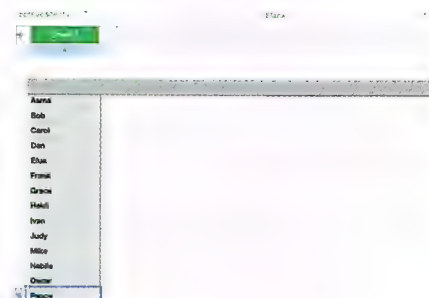
4 ENTER DUMMY DATA

We don't know what scores out of 100 everyone will get, so just for now, double-tap the first cell (B2), tap the '=' icon and enter `RANDBETWEEN(0,100)`. Pinch to zoom out, and autofill this across all cells, then down.



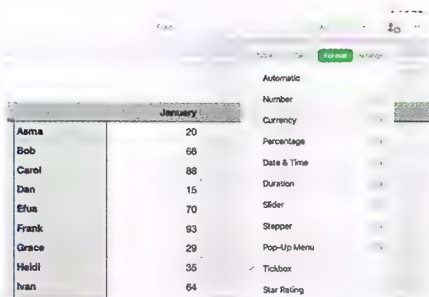
7 WRITE A VLOOKUP

Double-tap cell B2, tap the '=' icon and type `VLOOKUP` (true followed by a comma, then go to Sheet 1 and drag-select all the cells. Tap the up arrow at the right of the range and turn on all the 'Preserve' switches.



2 ENTER SOME DATA

We want to summarise the data for each person, so start by entering names in the first column. (If you wanted your summary sheet to show data for each month, you could list months vertically and people horizontally.)



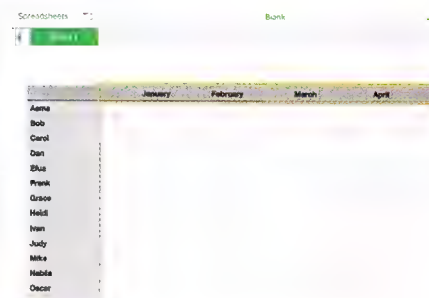
5 ADD TICK BOXES

Tap 'A' to select the first column, pick Column Actions from the menu and tap Add Column Before. Drag to select Rows 2 to 22 of the new column (A2:22), tap the formatting paintbrush and set Format to Tickbox.



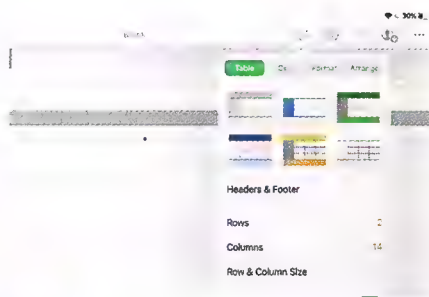
8 REPEAT FOR ALL COLUMNS

Add a comma, then `COLUMN()`, and click the green tick. In Sheet 2, autofill this function across the row. You'll see red triangles. Go back to Sheet 1 and tick one of the boxes. Sheet 2 will now fill with that row's data.



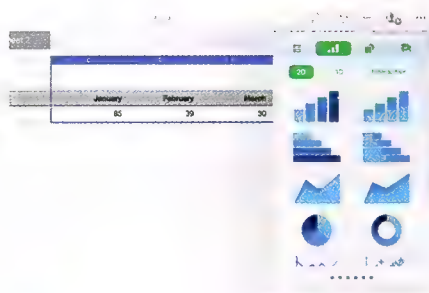
3 AUTOFILL MONTH HEADINGS

Type 'January' as the next column heading, then tap Cell at the top right of the on-screen keyboard (or bottom right of the screen), tap Autofill Cells, and drag the right handle of the yellow box across to fill in 12 months.



6 ADD A SECOND SHEET

Tap the plus sign at the top left and pick New Sheet. Size the default table to 2 rows and 14 columns. We now want to fill this with the data series for whichever participant is ticked on Sheet 1. Time for a VLOOKUP!



9 ADD A CHART

Double-tap cell C1 in Sheet 2, tap '=', go to Sheet 1 and tap the same cell ('January'). Autofill this across the row. Drag-select all the columns from C onwards, tap '+' at the top right and pick a chart type to add.

Optimise your media with smart tags

Nick Peers takes an in-depth look at media metadata to come up with some strategies to improve your file-tagging techniques.

Metadata – the art of ‘tagging’ your photos, films and music with extra information to help identify it – may not sound like the sexiest of subjects, but when you’re setting up a new media server or wanting to browse your photos through an app like Shotwell, you can instantly recognise your files and organise them as you see fit.

Metadata is, according to the Merriam Webster dictionary, “data information that provides information about other data”. The other data in this case is your media files; the data information is everything from a TV show’s episode title to the composer of a music track. Broadly speaking, metadata resides in one of two places: within the database of a related program such as your

music player or media server, or embedded in the file itself as a series of keyword ‘tags’. Often, program metadata is richer than the tags embedded in files – just look at the kind of information supplied by the likes of Kodi (<https://kodi.tv>) or Jellyfin (<https://jellyfin.media>) in terms of detailed synopses, cast and crew information and artwork. While you’re able to edit all these by hand, most of it is downloaded – or ‘scraped’ – from online databases such as IMDB or The TV Database. It’s effortless, but ultimately most of that information is tied to the program in question.

While simpler keyword-based tagging isn’t as detailed as the metadata available elsewhere, it does serve a useful purpose: namely, the tags are stored in the files themselves,

making them platform-independent. It also helps to confirm the identity of each media file by adding key information such as the artist name or TV episode title, which in turn can be used by apps that don’t make use of the metadata stored in third-party online databases.

For scraping or tagging to work, you need to organise your files in a specific folder structure, plus name them a certain way to help programs, tag editors and ultimately yourself identify them. The box on the opposite page reveals how this works in practice, and also shows you how to quickly rename hundreds of files at once, if necessary.

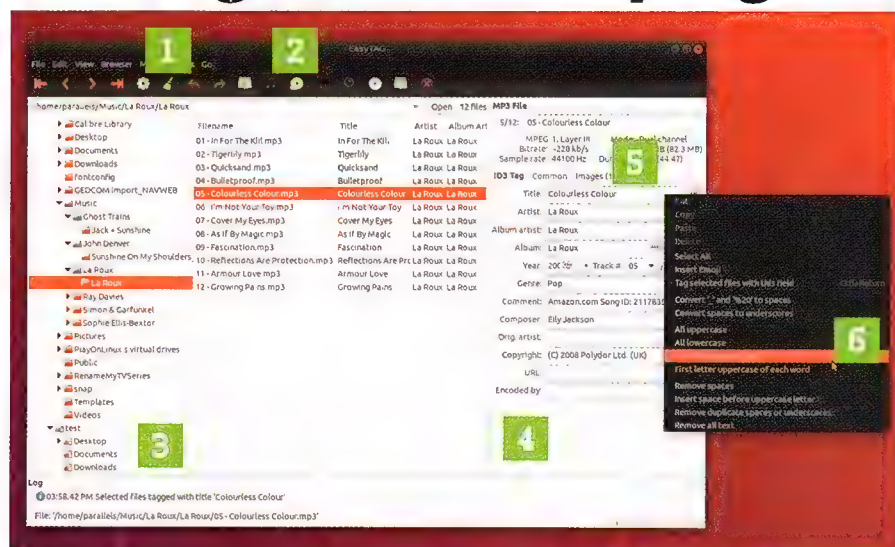
FILE-BASED TAGS

While most music and film/TV files share similar tags, the sad fact is that – like the proliferation of file formats and containers – there’s no single standard for tags. Instead, separate tag systems exist depending on which file format you’re using. For the purposes of simplicity, we’ll focus on the most popular open formats: MP3, Vorbis OGG and FLAC for music, and MP4 and MKV for films.

MP3 stores its metadata inside ID3 tags. Confusing matters further is the fact that ID3 tags come in two versions, but we’ll focus on the newer, more flexible ID3v2 tags. Vorbis OGG and FLAC use their own native tagging system, which are identical to each other and collectively known as Vorbis comments. Confusing matters even further than that is the fact that some FLAC files can also contain ID3 tags, which can cause problems on some systems.

MP4 files support three widely supported tag sets: iTunes, ISO-defined tags and 3gpp-defined tags. Unfortunately, all these sets are optimised for music rather than TV shows or films. They can, however, be adapted; for example, Title refers to a film or episode title, while Artist refers to a film director or the title of a TV show, as does Album Artist. Album Title is used to define the TV show and season – for example, *Detectorists Series 1*. Track can then be used to denote episode number, while Year

Getting around EasyTag



1 REMOVE TAGS
Click this button to remove all tags from the currently selected file or files.

2 SWITCH VIEW
Click these buttons to switch between directory tree view and browsing by artist/album.

3 NAVIGATION TREE
Use these two panes to find and then select files; Ctrl-click or Shift-click for multiple selections.

4 EDIT MANUALLY
View and edit individually selected tracks' metadata from this pane. Just click and type.

5 EMBED IMAGE
Switch to the Images tab to physically embed album or single artwork in the file.

6 QUICK EDITS
Right-click a field to reveal additional options, such as quickly converting the letter case of a tag.

and Genre fields can be filled in as required – so Comedy, Sci-Fi, Drama, and so on.

MKV files are awkward in that tags aren't embedded into the file itself; instead you must create one or more XML files containing all the tag information following a specific format. This can be a single XML file for your entire collection or broken down to one file per DVD or episode. You can do this by hand – see <https://matroska.org/technical/specs/tagging> for details.

While tags aren't as rich as the metadata offered by scraping services, you can still record a lot of detail in your file-based keyword tags. Available tags go far beyond simply offering an artist name and track name – you can also record data about the parent album name (and album artist name if it's different to the artist – for example on a compilation album), track composer, track number and disc number for multi-disc albums. ID3v2 tags also extend to support films and TV shows in the form of episode names, series and episode number. It's also possible to embed artwork into files.

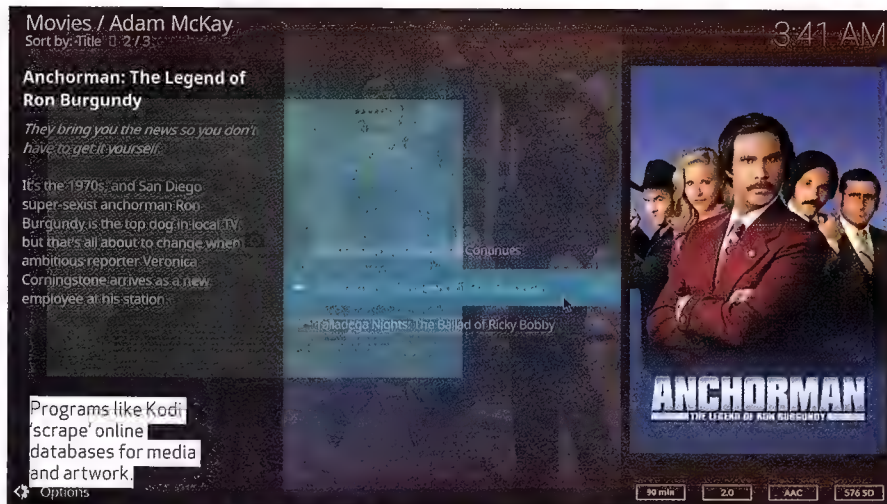
ADDING AND EDITING TAGS

When you buy music online, the tracks should come with metadata filled in. The same is true when you rip a CD using a tool like `fre:ac` (www.freac.org) – it searches the CDDB online database, then downloads artist, album and track information before embedding the tags into whichever file format you rip the disc to.

Tools like Handbrake for video-file ripping and conversion don't provide any metadata, so you'll need to add these manually later. Ironically, the command-line tool powering Handbrake – `FFmpeg` – does enable you to embed metadata into files, but it's not particularly user-friendly.

Ubuntu enables you to view a media file's core tags, but not to edit them. Simply right-click the file and choose Properties > Audio/Video to get information such as title and artist. If you're at the command line, browse to a file's parent directory and type `ls -l <name of file>`. You can edit tags manually in `fre:ac`, but a simpler solution is to open Software Centre and search for EasyTAG. This handy tool lets you view, edit and download music (but not film or TV) tags from both the freedb and MusicBrainz online databases.

The program can take a little getting used to: manually viewing and editing tags is simple enough, as you can see on the left. You can



also opt to embed album or single artwork directly into each music track; the benefit of this is that you ensure a copy of the artwork is always available, plus you get to choose what quality of artwork to provide.

Artwork can be found online – do an image search for an album or single title and maybe 'CD' if the title's too broad – or you can scan in CD covers and then edit them. 600x600 pixels is a good size, and save it in JPEG format to reduce the file size. The JPEG is embedded into each file you tag it to, thus can have a cumulative effect on the size of your media files.

There are several tools to quickly generate and update tags too. When it comes to generating tags where none exist, click the CDDB search button on the main toolbar to open a separate window.

Type your search terms into the Search box – if searching for a compilation album, include 'Various' as the artist name if necessary. Use the 'Search Fields' box to filter the

search by one or more of artist, album, track name or 'other' (all other fields, such as composer). You can also filter by category, but in the first instance it's usually best to keep the search as wide as possible.

Results appear listed by Artist/Album – click one and that album's tracks appear in the right-hand pane. Click each track in turn, and you'll see the corresponding track highlighted in the file navigator pane. Assuming your filenames have been named with the track number as a prefix, you should find they match up perfectly to the album from the CDDB search. If this is the case, click the 'Select all lines' button beneath the Results window and you should see that all the tracks are selected in both the CDDB Search window and the main EasyTAG window. Click Apply and all the tags will be assigned.

What if your filenames don't have the all-important track number to keep them in the correct order? Tick 'Match lines with the Levenshtein

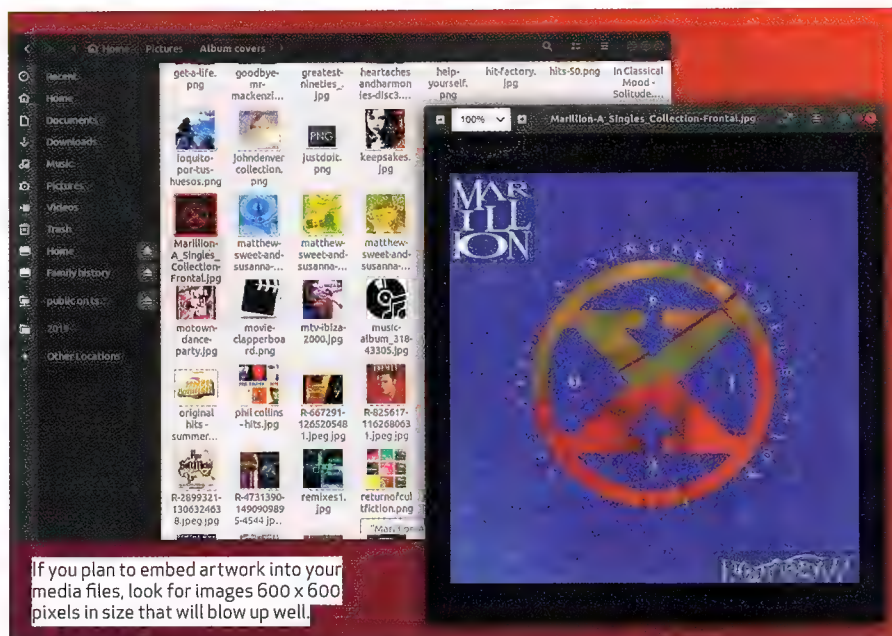
File naming conventions

To improve a program's chances of correctly identifying your media whether it's tagged or not, you need to adopt a certain file and folder naming convention.

For example, music files are traditionally stored with the folder structure Artist > Album > 01-track name.mp3. Things get more complicated when you start trying to organise your TV shows and films. Films are simpler; it's more about the naming convention: film title (year).mp4.

TV shows require organising in the same way as music: Show title > Series 1 > show title – S01E01.mp4. The good news is that these conventions should fit for most music players and media servers; the bad news comes if you've not named them correctly. There are variations on the standards listed above, but it helps to be consistent.

For most people, bulk-renaming TV shows presents the greatest challenge due to the number of episodes involved. Head over to <http://bit.ly/lxf256rename1> where you can download and run the free RenameMyTVSeries tool; prerequisites for this include libssl-dev, sqlite3 and libsqlite3-dev. It's simple to use: search for and select your TV show, then pick out the episodes and finally add in your misnamed files.



algorithm' before performing your search, and when you click each track in the results pane you should find the correct tracks are marked in the main EasyTAG window, thus enabling you to click Apply. Nothing gets written to the actual files until you press Ctrl-S – if you navigate to another folder, you'll be prompted to confirm your changes, where you can click Discard or Save depending on what you want to do. Before saving, you can undo changes or click 'Remove tags' to wipe all existing tags and start again.

USE PATTERN MATCHING

Another technique is to use the Tag and Filename Scan, which lets you

quickly fill in tags using information in the folder and filenames, rename files based on existing tags, and perform quick fixes to tag fields. This includes changing the letter case, along with converting special characters and spaces.

Select 'View > Show Scanner' to bring up the window. To create tags using filename and folder information, select the Fill Tag tab. The tool uses fill masks to extract the required information. There should be a legend explaining what each mask means – for example, '%b' is 'album' – but if it's missing click the Show/Hide Legend button in the top right corner.

What you need to do is to pick the correct file mask to match your folder structure of artist/album/01 – track name.mp3. There's a drop-down menu of preset choices, but none quite fit. However, if you select '%a-%b/%n-%t' from the drop-down menu, then change it to %a/%b/%n-%t you should find it now matches perfectly. Click 'Scan files' and all selected files in the main window are tagged accordingly. Having to do this manually for each album in your collection would be time-consuming, so save time by adding your new mask to the list of available masks: click the Show/Hide Masks Editor button followed by the 'Create...' button. Copy and paste %a/%b/%n-%t into the 'New_mask' box. Once done, click the + button to make it the default mask followed by the 'Save masks' button.

Switch to the 'Rename File' tab if you want to rename your tracks using information from your tags. It's typically used to add the track number to the front of the file where it doesn't exist, and the default '%n - %t' choice should work in most cases.

Finally, the Process Fields tab enables you to tidy up various fields – for example, by capitalising the first word of song titles, or by removing or converting unwanted characters such as '%20' to spaces.

EDIT FILM TAGS

While it's technically possible to edit MP4 tags in EasyTAG, this is not ideal. Translating the tags isn't the issue here as we've already explained, but you'll only be able to tag files by hand: EasyTAG's automatic search servers (see Edit > Preferences > CDDb) are audio-only, namely freedb.org and MusicBrainz.

If you want to tag film and TV files quickly, you'll need to install a Java-based app: tinyMediaManager. The step-by-step guide opposite reveals how it works. Sadly none of this information is embedded into your MP4 files; instead, the metadata is stored inside a single NFO file which is optimised for Kodi and written in XML format.

All artwork is downloaded as separate images, and all these files are placed in the same folder as the file they're providing metadata for, sharing similar filenames to make them easy to identify. It's less elegant than embedding the information directly, but it allows more metadata to be stored and is recognised in other programs too, such as Jellyfin. If you do go down this path, we'd recommend storing films in separate folders to keep things reasonably organised. ■

Tagging audiobooks

Because audiobooks use the same tags as your music files, you need to 'translate' audiobook information to music-based tags.

There's no common standard for which tags to use, so much will depend on how your audiobook player translates those tags.

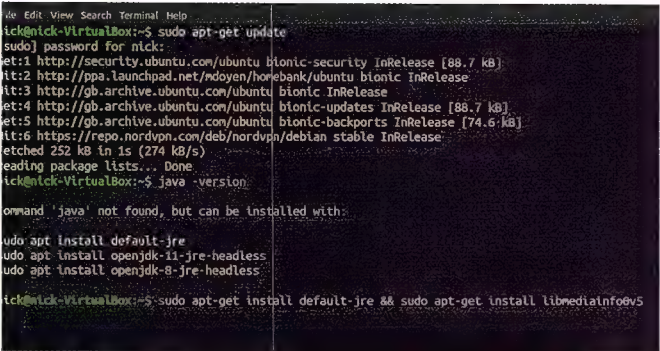
Try the following tag scheme: Author (First name Last name) should be Artist, while Narrator (again First Name Last Name) should be Album Artist. Use Album Title to record the book's title. If your audiobook is split across multiple files, use the Title field to record chapters or parts (for example, Chapter 1, Part 1); if not, record the book's title here too. Don't forget disc and track number information if relevant. Finally, use a single genre – Audiobook – to help filter your audiobooks in other programs.

All this tagging must be done by hand, unless you're an Audible user, in which case you can use OpenAudible to download your previously purchased books in MP3 format, complete with ID3v2 tags and embedded artwork. You'll need Java, then download the DEB version of OpenAudible from <https://openaudible.org>. Open a terminal window and use the following commands from your Downloads directory:

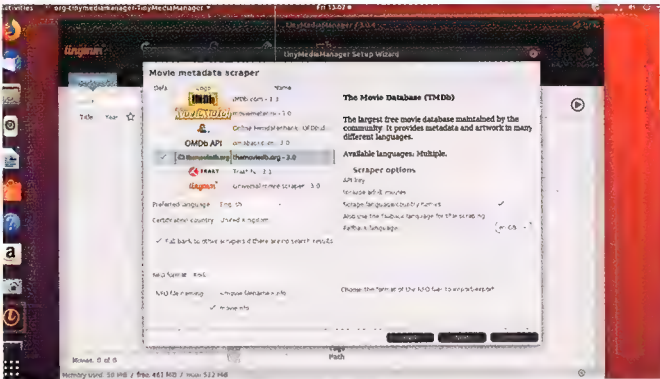
```
# sudo dpkg -i OpenAudible_deb_1.5.3.deb
# sh /opt/OpenAudible/OpenAudible
```

When it opens, press Ctrl-B to open your browser, navigate to the Audible website and log into your account. Once connected, your library should appear ready for you to download.

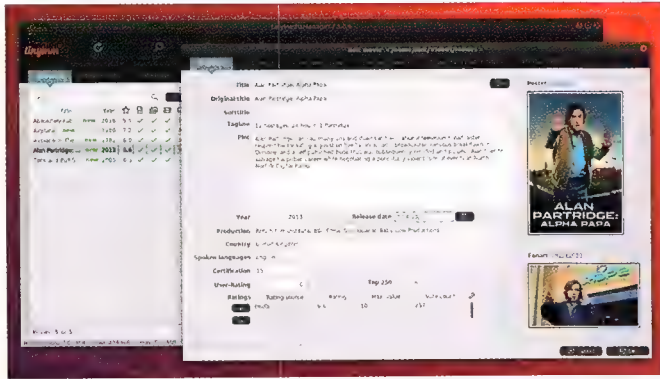
Tag films and TV shows



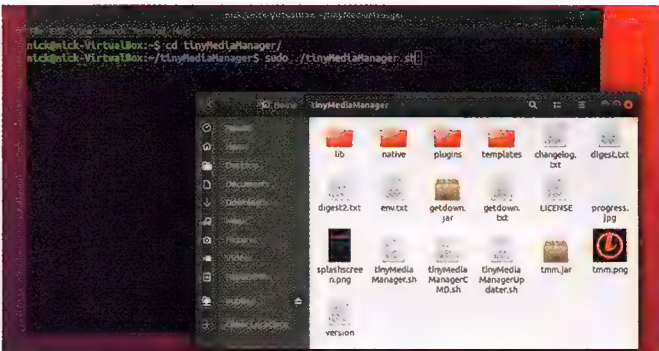
1 GET PREREQUISITES
Start by verifying that Java is installed:
`sudo apt-get update`
`java -version`
Assuming it's not installed, type the following to install it together with libmediainfo:
`sudo apt-get install default-jre libmediainfo0v5`



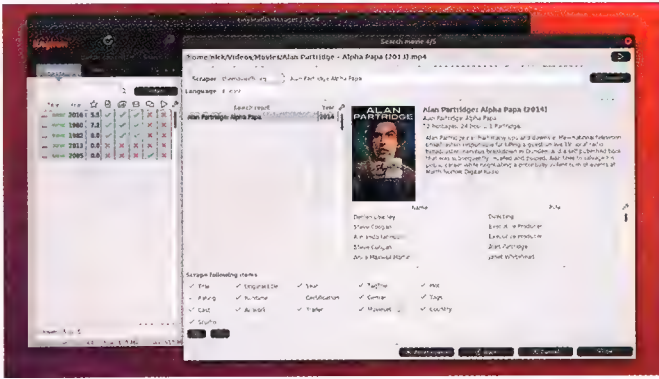
2 CONFIGURE BASIC SETTINGS
Follow the wizard's steps. When prompted to specify film datasources, click + to select the parent folder containing all your films (we recommend separating TV shows and films into two separate folders). Click Next, then choose your preferred metadata agent and fine-tune its settings, say for English. Click Next to repeat the process for your TV shows.



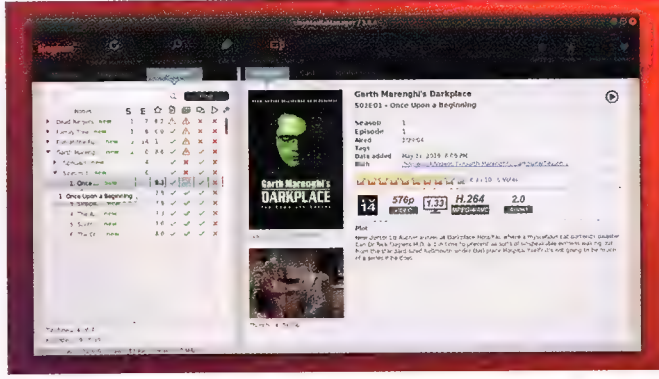
3 REVIEW AND EDIT
Once the search completes, you'll see that loads of information has been added, including posters and fan art. Everything is fully editable – select the film in question and click the Edit button to make any changes you need to – but sadly the metadata isn't saved to your MP4 files. Rather, it's stored in separate files for tags (in NFO format) and as artwork.



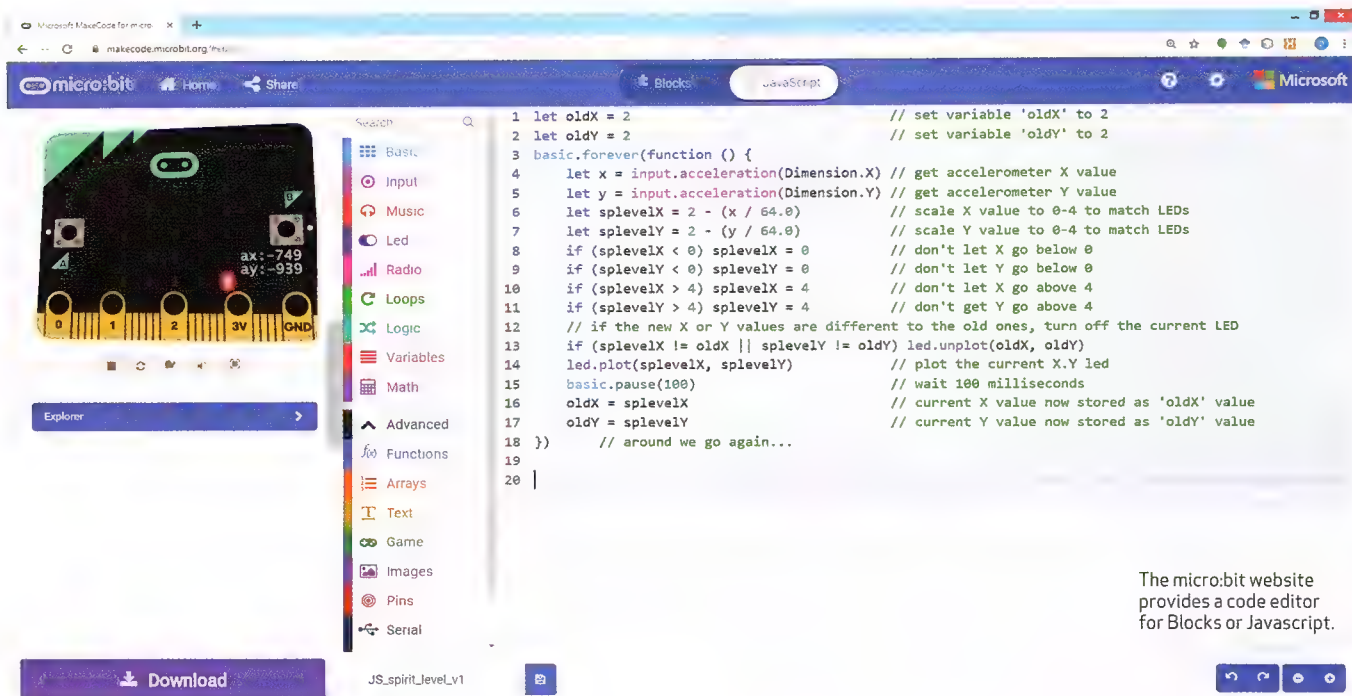
4 INSTALL AND RUN TINYMEDIAMANAGER
Open your browser and head to www.tinymediamanager.org to download the Linux version. Extract its contents to a suitable folder. Once done, return to the terminal and use the following commands (they're case-sensitive):
`cd tinyMediaManager`
`sudo ./tinyMediaManager.sh`



5 MATCH FILM TITLES
After clicking Finish, select your films from the list in the left-hand pane and click 'Search & scrape'. A window opens with a list of potential matches. If your film is present, select it, choose which items to scrape and click OK to move on to the next. If it's not, you can amend the search terms and choose a different online database to pull data from.



6 REPEAT FOR TV
It's a similar process for TV shows: switch to the 'TV shows' tab in the left-hand pane to view and select them. After scraping, click the > next to a TV show to review the metadata at a series and episode level. Again, all the details are editable, and you can use the tickboxes next to each show or episode's name to quickly adjust missing metadata or artwork.



The micro:bit website provides a code editor for Blocks or Javascript.

Code micro:bit wirelessly with Android

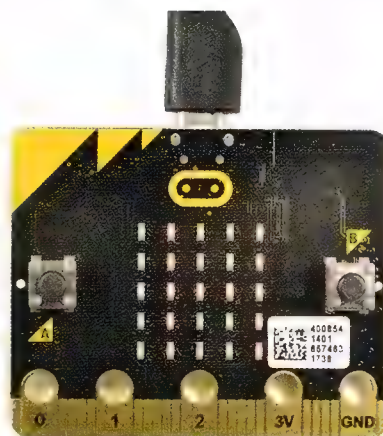
Who says you can't make stuff with an Android device? Get coding the BBC micro:bit maker board using your Android phone via Bluetooth. Darren Yates explains how.

Learning how to make your own stuff, even just learning how stuff works, is one of the most empowering skills you can gain. Over the years, we've shown you how to make all sorts of cool gadgets from drones to digital audio recorders, robots to tiny oscilloscopes – and all featuring small, low-cost microcontroller boards. Microcontrollers differ from your average PC microprocessor in that a microcontroller is a self-contained CPU chip with its own limited amount of RAM and storage, but also a number of input/output (I/O) ports. The RAM and storage are nowhere near enough to run Windows, but more than enough to run your own code to perform cool tasks such as interact with sensors and light up LEDs. Still, it can all seem pretty daunting the first time you play around with these things, but thanks to the excellent BBC micro:bit board, not only can you code it easily on your PC, you can code it via your Android phone or tablet via Bluetooth.

DESIGNED FOR (BIG) KIDS

The micro:bit board features 25 LEDs in

a 5x5-grid, along with two momentary-on push-button switches. However, what's really cool about this board is that it has built-in Bluetooth, plus an accelerometer sensor, very similar to the one in your Android phone. It connects to your PC via USB, but after you load in your first project, it'll also now load in new firmware enabling the micro:bit board to connect via Bluetooth



The micro:bit board features 25 LEDs, Bluetooth and accelerometer sensor.

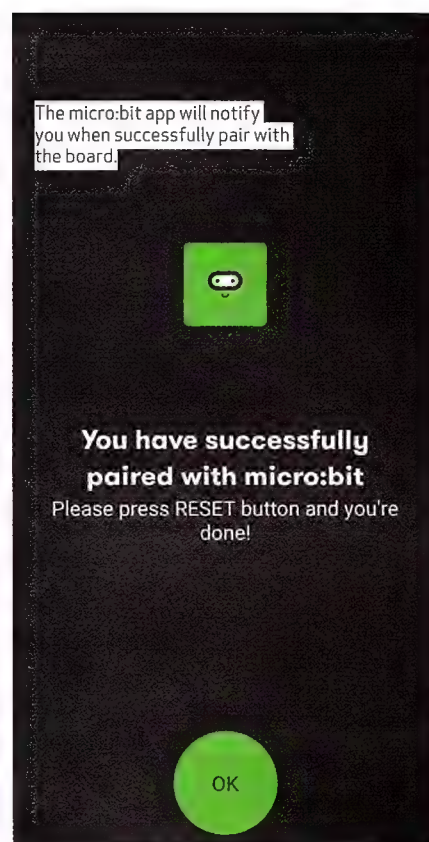
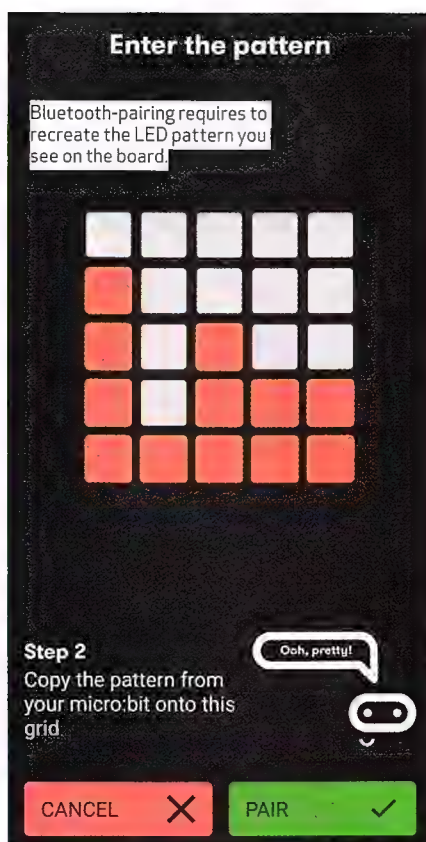
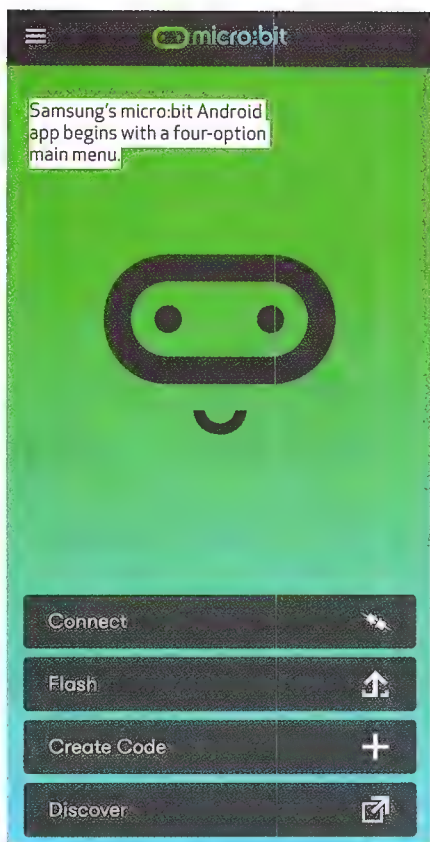
and to your Android phone. The basic 'micro:bit Go' kit, including micro:bit board, USB cable and AAA battery pack, sells in Australia from specialist 'maker' retailers for around \$30.

WHAT YOU'LL NEED

Actually, not that much – you just need an Android 4.4 or later phone or tablet with Bluetooth, the free micro:bit app from Google Play (tinyurl.com/y6mm44p2), a Micro:bit board, and initially, a PC with its browser pointing to makecode.microbit.org. As a simple project, we're going to load up the micro:bit with new Bluetooth-pairing firmware, then we'll use the Micro:bit Android app to create code turning the Micro:bit into a toy 'spirit level' (usually used for setting up horizontal surfaces). Finally, we'll flash the compiled 'hex' code to the Micro:bit board via Bluetooth using Android.

MAKE A 'NOTHING' APP

Depending on how old your micro:bit board is (or if you've previously coded it in Python), it may not have the latest firmware to enable Bluetooth pairing



"What's really cool about this board is that it has built-in Bluetooth, plus an accelerometer sensor, very similar to the one in your Android phone."

with your Android device. So, first thing to do is plug the board into your PC, head to Microsoft's makecode.microbit.org website and click on the purple 'New Project' tile. That will bring up the micro:bit code editor window with the 'Blocks' graphical language editor ready to go. However, right now, all you need to do is press the 'download' button. By default, the Bluetooth-pairing code is added to any new project, even if it's a 'do nothing' loop. Once the 'microbit-Untitled.hex' file downloads, open up Windows' File Explorer and copy the file across to the micro:bit drive letter. That's it. The micro:bit will automatically install or 'flash' the file to its internal storage. When that's done (when the yellow LED on the board stops flashing), we're ready to pair it with your Android phone. If you have a separate power source you want to connect your micro:bit board to, do so now and turn off your PC – we don't need it any more.

PAIRING MICRO:BIT AND ANDROID

Turn on the Bluetooth feature on your Android phone via the Settings menu

and plug your micro:bit board into whatever USB power source you want to use. Now the board itself has two buttons on the front marked 'A' and 'B', plus a third 'reset' button on the back near the microUSB socket. Hold down both 'A' and 'B' buttons, press and release the 'reset' button and release the 'A' and 'B' buttons when you see the Bluetooth logo appear on the front LEDs. The micro:bit board will now be in 'pairing' mode.

Next up, launch the Micro:bit app you installed from Google Play and after the animation, you'll see four menu options. Tap 'Connect' and on the new screen, tap the 'Pair a new micro:bit' button at the bottom. The new instructions show the key-press sequence we've just done, so you can now press the 'Next' button and your job now is to replicate on the app grid the pattern showing on the micro:bit LED grid. When you're done, press the 'Pair' button. Once a connection has been made, you'll be notified on the app and a big red tick will appear on the micro:bit LEDs. Press the round 'OK' button on the app and now tap the entry box at the top of the

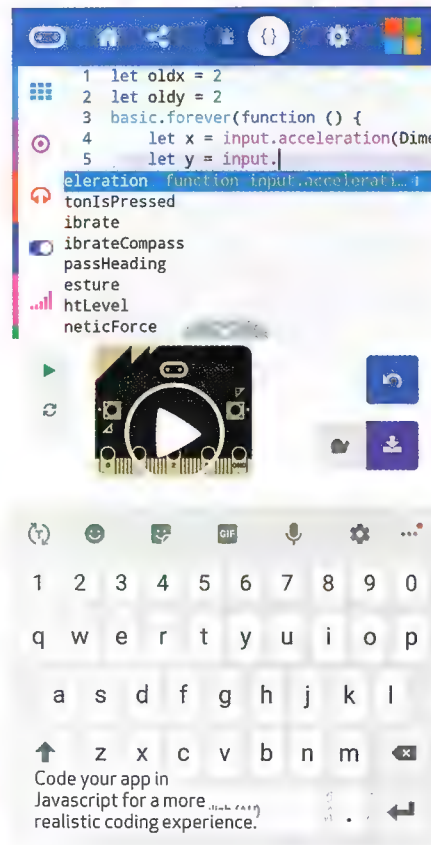
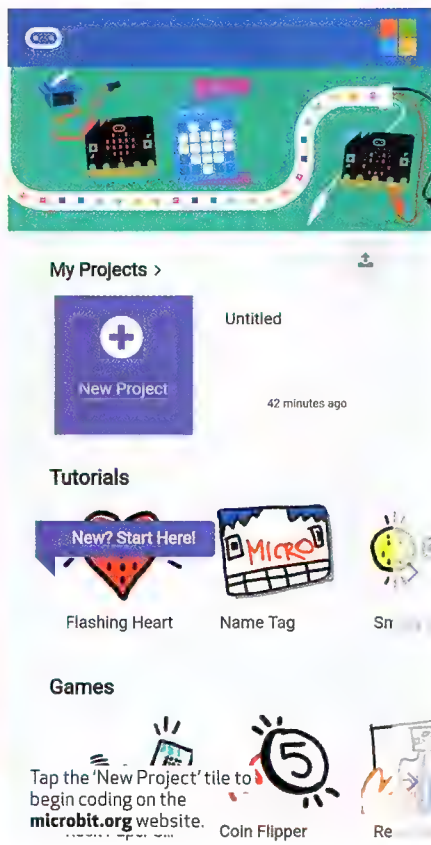
new screen under 'connect previously paired micro:bit' to connect your phone to the board (I found re-doing the 'A-B-reset' key sequence helped at this point). Once connected, the entry box will turn white. Now press the back arrow to go back to the main menu and tap 'Create code'.

WRITING YOUR FIRST MICRO-BIT APP

Tapping 'create code' will take you to the microbit.org website. Scroll down until you find the 'MakeCode Editor' and tap on 'Let's code'. Now, as before, tap the purple 'New Project' tile and we'll get coding.

The default coding option micro:bit offers is the graphical language called 'Blocks'. Personally, I'm not of a fan of graphical-based languages like Blocks because I think they create a false paradigm. Coding in the real world is text-based and it's much better to learn standard coding techniques, rather than graphical drag-and-drop methods you won't be able to use almost anywhere else. Okay, end of rant. Instead, we're going to code in a simplified form of Javascript (yes, Blocks is also simplified, but the Javascript here gives a 'much closer to real world' experience).

So, to turn the editor from Blocks to Javascript, there is a slide switch at the top-middle of the Editor screen – tap on the two curly braces and it'll switch to Javascript mode.



Before we go on, an important public service announcement – you cannot code your micro:bit board using Python if you wish to code via Android and Bluetooth. The 'micropython' code interpreter that converts your Python code into machine code the micro:bit can handle only just fits within the micro:bit's internal storage and in doing so, it wipes the Bluetooth-pairing code. So, to code wirelessly you have to code in Javascript. However, in practice, as we'll see, there's not too much of a difference between the two, so if you know Python, the Javascript language here won't be too unfamiliar.

it available on the APC website,
download it from [www.techradar.com/
au/news/apc-magstuff](http://www.techradar.com/au/news/apc-magstuff)

The great thing about microcontroller chips (and the micro:bit is no different) is that they're quite simple to code. Initially, the code editor window is preset with a 'forever' function, which is just a fancy way of saying it starts you off with a code loop that once started, runs on your micro:bit board until the power is removed. Like many coding languages, the Javascript code is processed, starting from the top, one line at a time and when it hits the last indented line before the closing brackets, it goes back up to the first indented line and starts again.

The micro:bit's built-in accelerometer is able to measure the orientation of the board in the X- and Y-axes, similar to the one in your phone. If we consider the microUSB end of the board with the LEDs facing up as the 'front', the accelerometer gives a ready of [0,0] when the board is flat horizontally. Tip it forward to the left and it will read [-1023, -1023], tip it forward-right and you get [1023, -1023] and so on. If we talk about this in binary terms, the accelerometer gives us '11-bits of information' (the total range in each axis is effectively 2048, which is 2 to the power of 11, or 11-bits).

Looking at the code, the first two lines set up two variables we use to store the 'old' X and Y values. To ensure we get a good bright clean display, we only change the display if the X or Y values change and to detect a change, we store the old values away as a reference. The initial values of [2, 2] is the centre LED on the micro:bit display.

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sensitivity. Using '512' would make it barely register, but making it '1' would make it too sensitive and impossible to stabilise (here's experimental point 1 – change the values and see what happens). Lines 8 to 11 ensure our new scaled 'splevel' X and Y values remain within the range of 0 to 4.

Now line 13 is key – here, we're keeping an eye on the new 'splevel' X and Y values and we want to know if either of them has changed or is 'not equal' (!=) to their respective previous values (initially, these old values are the [2,2] as set in lines 1 and 2). If either value is changed, we turn off or 'unplot' the old LED and in line 14, we light up or 'plot' the new LED. Line 15 provides a 100-millisecond pause to slow the display down (experimental point 2 right here) and finally, lines 16 and 17 store away these current X and Y values. Why? Well, they're about to become the 'old' values as soon as they're stored and the code goes back to the start of the function loop at line 4 and begins again.

TIP: YOU DON'T NEED A MICRO:BIT

If you don't have a micro:bit board yet, you can use the virtual one on the

website and available on both PC and Android. Just below the code window on the Android app, you'll see an image of the micro:bit board and to the left, a green 'play' arrow. Tap on that arrow, then tap on the micro:bit board image. This will launch an emulator screen and if you press on the top-left of the micro:bit board, you'll see the 'ax' and 'ay' values change, as well as the LEDs. Unfortunately, it only allows you to press and release, not drag to see the LEDs move more smoothly (the PC version is better). However, nothing beats coding an actual micro:bit board.

SENDING CODE TO MICRO:BIT VIA BLUETOOTH

When you've finished coding, press the micro:bit icon button at top-left, choose a filename and press 'Save' (this will save the file to your device, but show it next to the purple 'New Project' tile). If you go back to the Code Editor window (tap the newly created file tile next to 'New Project'), there is a purple 'download' file button at the bottom right – press it and it will compile your code into a '.hex' file and download it to your phone's web-download folder.

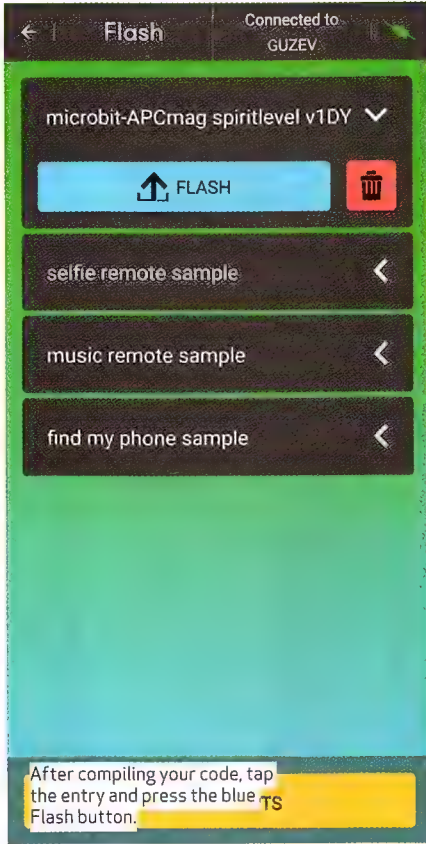
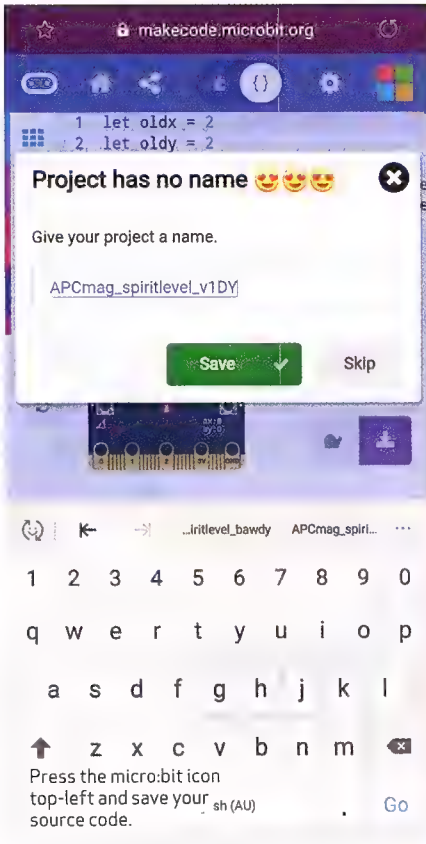
Now go back to the micro:bit app and tap 'Flash' on the front four-option menu. This will bring up your compiled file list with your new project file included. Tap on the file, then tap on the blue 'flash' button. Ensure your micro:bit board is paired and connected using the 'A-B-reset' key sequence from before and press the green 'OK' button. If all is well, you'll get the 'flashing' screen and a progress bar slowly making its way across. When its complete (it'll take a minute or so), your code will automatically launch and you should be able to move the micro:bit board around and watch the LED move in the opposite direction, just like the bubble in a genuine spirit level.

PHONE OR COMPUTER?

Sure, the more resolution your phone screen has, the better the experience will be. But the key thing is to realise just what your phone is capable of. Coding a microcontroller board via Bluetooth from your phone means you're no longer tied to a desk, or even a PC – and the micro:bit is just the start of your adventures.

However, if this has been your first taste of coding hardware or even just coding full-stop, hopefully, it's given you a glimpse of what's possible. I guarantee you we haven't even scratched the paintwork that covers the surface of where coding can take you. ■

"The great thing about microcontroller chips (and the micro:bit is no different) is that they're quite simple to code."



Push live system stats to the cloud

Les Pounder shows us how to create a Telegram bot that will show updates from a Raspberry Pi server and broadcast them to the world.

Telegram is an encrypted, private messaging service with an open API that is really easy to use. In this tutorial we shall build a Telegram Bot, code that reacts to commands issued by the user from inside Telegram. Our bot will give us the latest CPU temperature, CPU usage and current available RAM for a Raspberry Pi.

SOFTWARE SETUP

Before any code can be written, we first need to sign up for a Telegram account. There are many clients for Windows, Linux and mobile devices. For this tutorial it would be prudent to install the desktop client, but if you are completing the tutorial on a Pi, you can use the web version. With the account created and Telegram installed we can now start to create a bot that will react to messages. To do this we need to use The BotFather, an automated script that handles the creation and maintenance of Telegram bots. Open a browser to <https://Telegram.me/botfather> and then tell The BotFather that we wish to create a new bot.

/newbot

Follow the automated instructions and after a short while your new bot will be created. The BotFather will provide a URL to start our bot, and an API key. Copy the API key somewhere safe – we'll need this later. Click the link to start a conversation with your new bot. You'll see a start button at the bottom of the screen – click this to start the bot. That is all that we need to do in Telegram for now, but we will come back to it later.

On our Raspberry Pi we now need to install the Python library for this tutorial. Open a terminal and type

```
$ sudo pip3 install pyTelegramBotAPI
```

Close the terminal when complete.

CODING THE PROJECT

Open your preferred Python editor (IDLE, Thonny, Mu or similar) and create a new file. Save the file as TelegramBot.py and remember to save often.

We start the code for this project by first importing libraries that will provide the functionality in our

You need

- Any model of Raspberry Pi
- A desktop/laptop/mobile
- Internet connection
- Breadboard
- 2x 330 Ohm resistors (Orange, Orange, Brown, Gold)
- 1x LED
- 2x female-to-male jumper wires
- Code: <http://bit.ly/lxf256>

telegram

application. The first is the 'telegram' library for Python, then we import 'time' to control the pace of the code. Finally we import a library to enable Python to investigate system resources.

```
import telebot
import time
import psutil
```

The next step is to create an object that will provide a link for our code to the Telegram bot. This is handled via the API key, unique to our bot. The object `tb` creates the link.

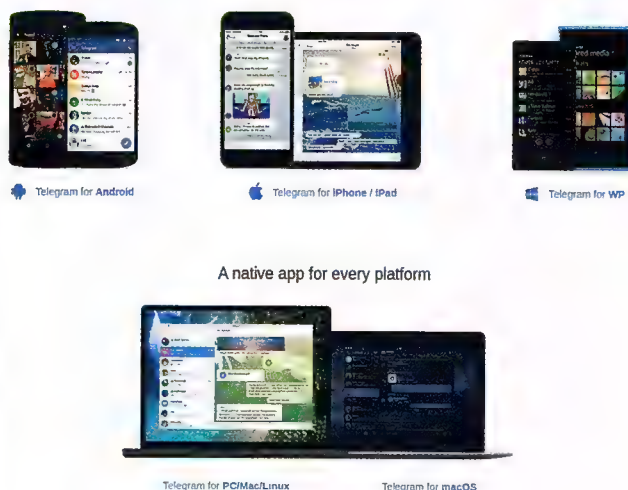
```
tb = telebot.TeleBot("Your API KEY HERE")
```

With a connection to Telegram created, we now create a handler that will react to a specific message from the user. The message is `/stats` and in order for it to be identified by the code we need to create a

"In this tutorial we shall build a Telegram Bot, code that reacts to commands issued by the user from inside Telegram."



Once set up, we just send the `/stats` message to get a reply.



A native app for every platform

Telegram is available on just about every platform you can think of.

test. The test is in a function that will check the contents of the message (`msg.text`) to ensure that it is not blank, and that it contains the `/stats` command.

```
@tb.message_handler(func=lambda msg: msg.text is not None and '/stats' in msg.text)
```

Next is the creation of a function, `send_welcome`, that will trigger the start of a flurry of activity. First a variable `temperature` is created and in there we store the output of the command to read all of the sensors on the Pi. But the output from this command is quite densely packed, so on the next line we update the contents of the variable so that it targets only the CPU temperature sensor. For the final step we convert the returned variable into a list, so that the contents can be easily selected.

```
def send_welcome(message):
    temperature = psutil.sensors_temperatures()
    temperature = (temperature['cpu-thermal'][:1])
    temperature = list(temperature)
```

As well as showing the CPU temp, we also want to show the CPU usage as a percentage, and the amount of free RAM available. It's just one line of code to get the CPU usage and store it in a variable called `cpu`. But for the memory we first need to save all of the memory information to a variable called `memory` and then extract the current available memory, which is stored in a list with an index of 1. This makes it the second item in the list. Then we use some maths to convert bytes to megabytes and the `round()` command to produce an easily readable value.

```
cpu = psutil.cpu_percent(interval=1)
memory = psutil.virtual_memory()
memory = memory[1]
memory = round(memory / 1024 / 1024)
```

Still inside the function, the next three lines handle replying to the user with the details of the server. First will be the CPU temperature. Using the `tb.reply_to` function we reply to the original message via a string. The string contains a sentence that will tell the user what the data is, and inserted into that sentence is the contents of the list `temperature` that we created earlier. But we only need a specific piece of information which is stored in index 1 of the list - this is the CPU temperature in Celsius. At the end of the sentence we add the letter 'C' to identify that we are using the Celsius temperature scale.

```
tb.reply_to(message, 'CPU Temperature is
```

Control the GPIO

In the tutorial we created a function that would react to a command from the user and post data to Telegram. We can also use Telegram to control the GPIO of a Raspberry Pi.

The code remains very similar to the tutorial code, but we use the GPIO Zero library and import the LED class, then we set GPIO 17 as the pin for our LED.

```
from gpiozero import LED
led = LED(17)
```

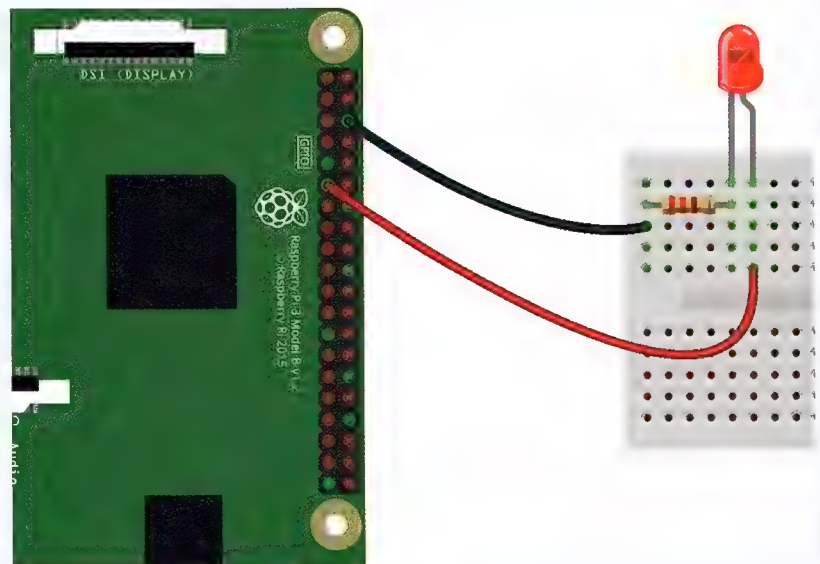
We then change the message handler to look for `/led-on`. If that command is issued it runs the GPIO Zero code to turn on the LED.

```
@tb.message_handler(func=lambda msg: msg.text is not None and '/led-on' in msg.text)
def send_welcome(message):
    tb.reply_to(message, 'LED On')
    led.on()
```

The code to turn off the LED is very similar to turning it on.

```
@tb.message_handler(func=lambda msg: msg.text is not None and '/led-off' in msg.text)
def send_welcome(message):
    tb.reply_to(message, 'LED Off')
    led.off()
```

Run the code and you can control an LED over Telegram! We've made a video demonstrating for more go see this: <http://bit.ly/lxf256telegram2>



Setting up an LED with the Pi is very simple, as you can see here.

```
'+str(temperature[1])+'C')
```

The next two lines provide the data for the CPU usage and the amount of free memory. They work in a simpler manner to the temperature line.

```
tb.reply_to(message, 'CPU Usage is '+str(cpu)+'%')
tb.reply_to(message, 'Free RAM is '+str(memory)+'MB')
```

This is the end of the function and we now move on to the final section of code, which is a loop to continually check Telegram for updates (`polling`) and to handle any error messages and the user exiting the code. Using exception handling we first try polling Telegram, but if the user requests to exit, an exception is raised and the code will

end. Another exception is when an error is raised; this typically happens after an hour of use. If so, the code will pause for 15 seconds before the loop repeats.

```
while True:
    try:
        tb.polling()
    except KeyboardInterrupt:
        print("EXIT")
        break
    except Exception:
        time.sleep(15)
```

The code is now complete and is ready to run. Start the code and then go to the Telegram application and send the `/stats` message to your bot. This will trigger the bot code to run and give us live stats from our Pi. It's as easy as that! ■

MapReduce: the 'Big Data' idea inside your Android phone

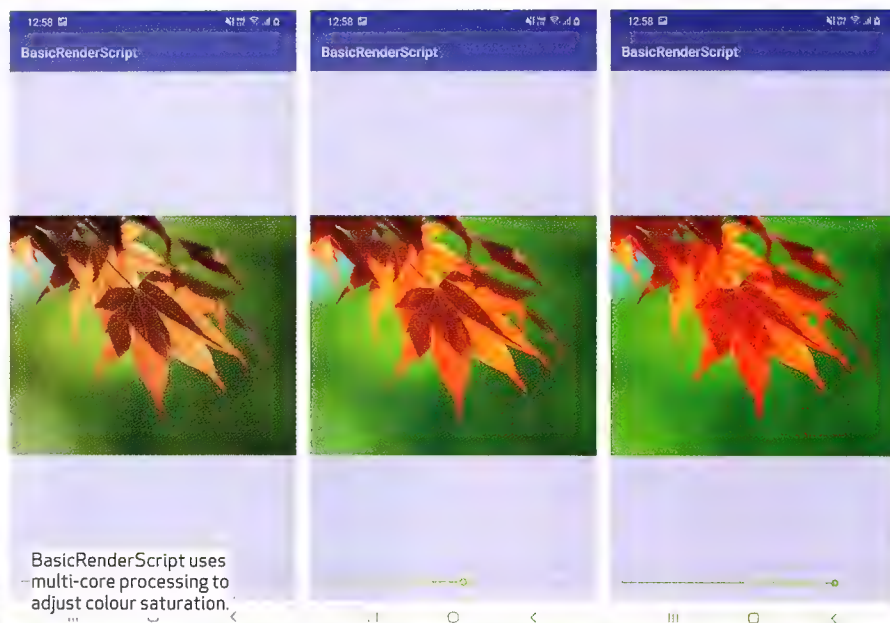
It's a common buzzword in 'big data', but what is MapReduce, how does it work and why is it in your Android phone? Darren Yates explains.

It's a few years old now, but IBM's oft-quoted statement that 90% of the world's data is created in the previous two years is mind-boggling when you think about it. Basically, we're swimming in a sea of data that's rising at a breath-taking rate. As PC users, we're used to the idea of multi-core CPUs and multi-threaded apps. However, when it comes to machine-learning this 'big data', new processing ideas are needed. What might surprise you is that some of those ideas have made their way into your Android phone.

WHAT IS MAPREDUCE?

Many machine-learning algorithms, like most 'decision tree' and 'forest' (collections of trees) algorithms, require the data to all fit into a computer's system memory. Before cloud computing, that wasn't always possible with big data, so 'distributed computing' was born. Here, groups or 'clusters' of computers each handle part of the data and the results are recombined at the end. The benefits here are speed and cost – by processing the data over multiple computers, the work is completed faster and it also allows the use of cheaper hardware. If you've tried SETI@home (setiathome.berkeley.edu) or other similar experiments, they're perfect examples of this 'distributed computing' idea.

MapReduce has been a bit of a 'big data' machine-learning buzzword over the last decade or so and refers to its



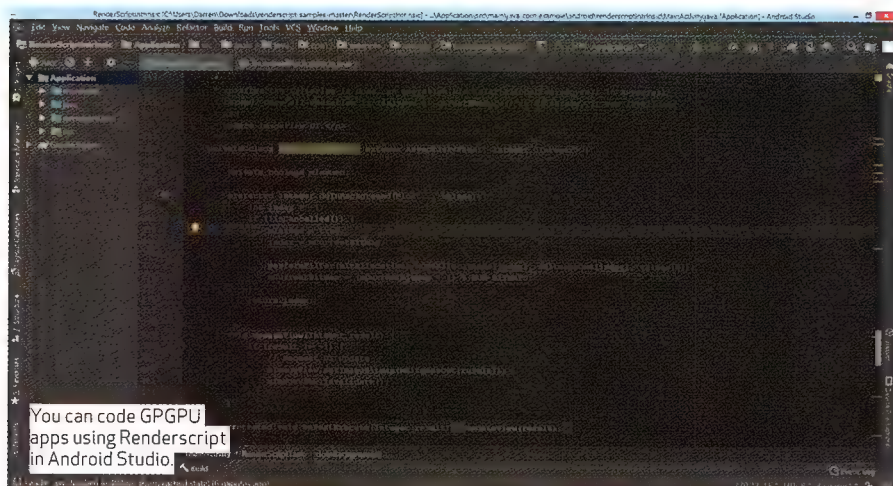
"Many machine-learning algorithms, like most 'decision tree' and 'forest' algorithms, require the data to all fit into a computer's system memory."

two main functions, used to process data in distributed environments, called 'map' and 'reduce'.

This will be a bit of a simple 'drawn with crayons' view of MapReduce, but

imagine your data exists as a typical spreadsheet with rows and columns and a single point of data in each cell. The Map function essentially allows a processing task or algorithm to be executed once on each cell, which is then transferred or 'mapped' to a new spreadsheet. So for example, if you start with a spreadsheet with 100 rows and 200 columns, you end up with a second processed spreadsheet based on the first. The Reduce function enables another processing task to combine or 'reduce' groups of cells to a single result at the end. A simple example often used to describe this is counting the frequency of words in a document. The Map function splits the documents into separate words, while the Reduce function counts up the occurrences of each word.

However, the key thing about the MapReduce framework is that it can be processed in parallel – you can throw



as many processor cores at it as you have to speed things up.

SO, WHAT ABOUT ANDROID?

Take a look at either the Samsung Galaxy S10 or Google's new Pixel 4 XL phone and each has a variant that includes Qualcomm's new Adreno 640 graphics processor unit (GPU), with its whopping 384 numeric pipelines or 'arithmetic logic units' (ALUs). By contrast, the old Galaxy S5 uses an Adreno 330 GPU with only 128 ALUs – but that's still 128 processing units able to work in parallel, but which are often employed only when processing 3D images for your favourite games.

The idea of 'general purpose computing on graphics process units' or 'GPGPU' came about to take advantage of the GPU's ability at processing simple mathematical tasks in bulk and to apply it to areas other than gaming. The most obvious example in the last five years has been the boom in Bitcoin mining, where multiple graphics cards are often crammed into PC boxes to process blockchain sequences and make new Bitcoins.

However, this highly parallelised processing of relatively simple mathematical task isn't just limited to PCs – it's also available in Android devices, thanks to a little known framework called 'RenderScript'. It's supported in Android versions going back to Android 2.3/Gingerbread and has been there ever since. What's clever about Renderscript is that it allows you to develop code that can run on a phone's CPU or GPU cores without you worrying about which core, the 'when' or 'how'. Android takes care of these issues, but it also decides when a CPU core rather than a GPU core runs your code.

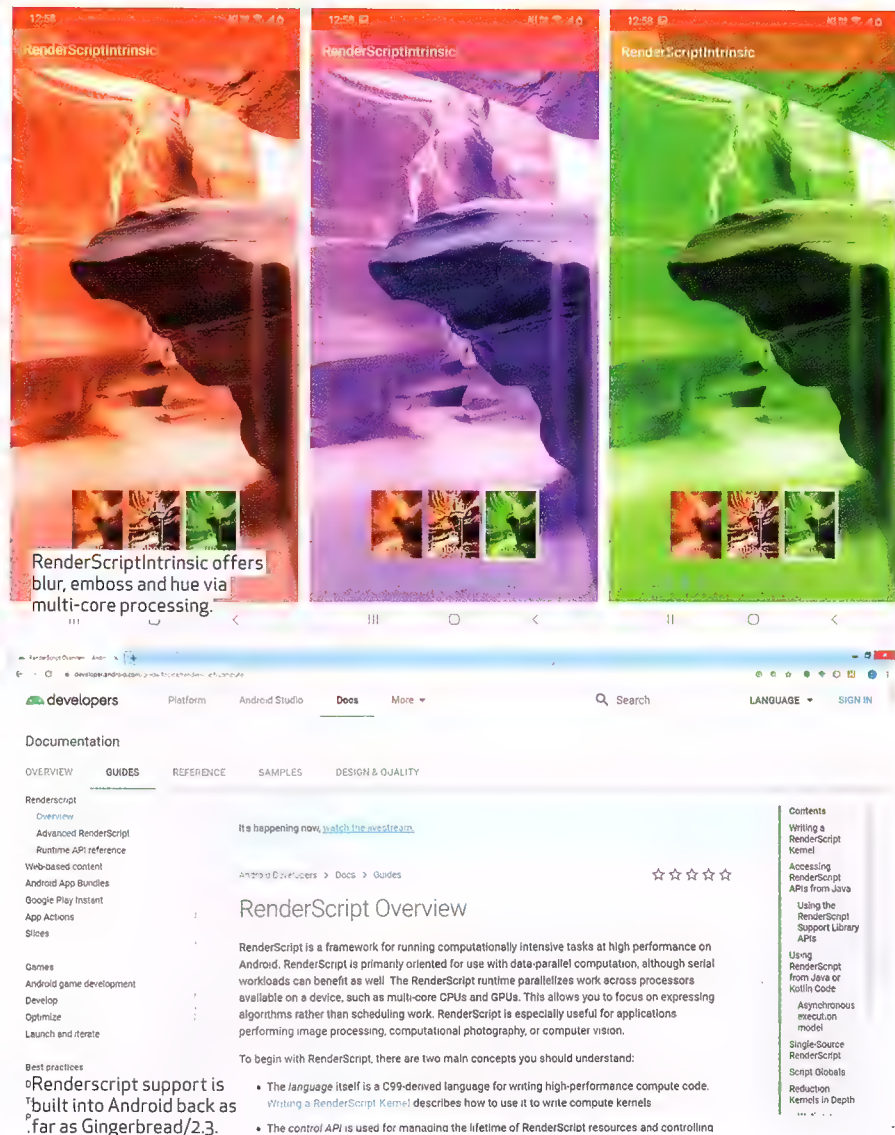
To implement the Renderscript framework, you write an algorithm or 'kernel' function that is executed by the Android device on your data. But here's the thing: Renderscript supports two standard types of kernel – a 'mapping' kernel and a 'reduction' kernel (sound familiar?).

HOW ANDROID USES MAPREDUCE

In Renderscript, a mapping kernel applies a single-executed transformation function to each value element in a memory block Google calls an 'allocation' and which you can think of as a data array, whether a list or a two-dimensional array like a spreadsheet.

Here's a quick quiz – what data structure does your phone often generate that appears for all the world like a big spreadsheet? If you said 'photos', give yourself a prize.

A digital photo is essentially a large two-dimensional spreadsheet where each 'cell' is a pixel holding a 24-bit



number, combining three eight-bit blocks identifying the red, green and blue colour components.

In fact, Google uses digital images as programming examples for implementing both Renderscript and mapping kernels to apply real-time transformations.

If you're interested in trying them out, you'll need an Android device, plus the latest version of Android Studio, which you'll find at <https://developer.android.com/studio>.

Google provides these examples at <https://github.com/android/renderscript-samples>.

The 'BasicRenderScript' example allows you to change the colour or 'hue' of an image in real-time using a slider control, while the 'RenderScriptIntrinsic' example allows you to similarly apply various visual effects to an image including blur, emboss and hue – again, all in real-time with parallel processing using your phone's GPU and/or CPU cores.

If you want to find out more about Renderscript, head to the Google

Developers' website at developer.android.com/guide/topics/renderscript/compute.

Renderscript has a setup overhead, meaning it takes a certain amount of time to setup before the parallel processing takes place. That also means it's not ideal for every application, particularly where only small amounts of data are to be processed (here, normal code running on the CPU would likely be more efficient). Still, GPGPU capability on a phone is pretty cool.

MORE THAN ONE USE

MapReduce scored its fame as a buzzword thanks largely to Hadoop, the open-source Java-based big-data distributed computing environment. These days, Hadoop seems to be on the decline, due to the combination of cloud computing and faster alternatives, principally Apache Spark. However, the MapReduce framework is still incredibly useful – and the fact is, thanks to Renderscript, you're likely carrying it around in your pocket. ■

downtime

WHAT'S HAPPENING IN THE WORLD OF FUN, WITH SHAUN PRESCOTT.



Bethesda closes one studio, opens another

HUMAN HEAD STUDIOS SHUTTERED IN FAVOUR OF ROUNDHOUSE STUDIOS.

Just days after the release of its latest action RPG, *Rune 2*, Human Head Studios has been closed by its parent company Bethesda. The studio was responsible for the original *Prey*, but most of its team has been rolled into a brand new studio by the name of Roundhouse Studios, which is already at work on some "mystery projects".



Assassin's Creed creator once again confirms Amsterdam 1666 is still happening

"I'M BACK AT IT," DÉSILETS SAYS.

At Reboot Develop Red in Canada, Eurogamer asked *Assassin's Creed* creator Patrice Désilets how serious he is about working on *Amsterdam 1666* now that *Humankind Odyssey* is out. Désilets told *Eurogamer* he's so serious he almost lost his house over it. The mysterious game has been in development since 2012, but got tied up in an IP rights battle between Désilets and Ubisoft.



John Carmack scales back VR commitments in favour of AI

He'll stay on at Oculus as a consulting CTO.

Games industry legend John Carmack, best known as the talent responsible for the technology behind games like *Doom* and *Quake*, has announced he will scale back his work in the VR space in favour of a move towards "artificial general intelligence". Carmack joined Oculus in 2013 as its CTO, and will henceforth work as a "consulting CTO" for the company.

Days before the announcement Carmack had received a Lifetime Achievement Award at the VR Awards, during which he expressed dissatisfaction with the pace of progress in VR development. Announcing his move in mid-November, Carmack reflected on his career thus far. "As for what I am going to be doing with the rest of my time: When I think back over everything I have done across games, aerospace, and VR, I have always felt that I had at least a vague 'line of sight' to the solutions, even if they were unconventional or unproven. I have sometimes wondered how I would fare with a problem where the solution really isn't in sight. I decided that I should give it a try before I get too old."

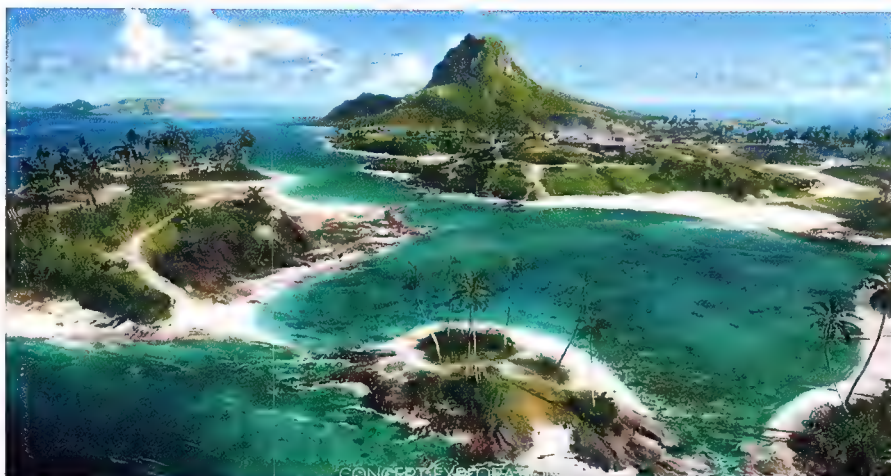
Outlast studio teases new game, most likely within the Outlast universe

OUTLAST VR?

It was a bountiful Halloween for horror fans, as the studio behind two of this generation's scariest games just teased something new. *Outlast* developer Red Barrels, known on twitter this season as 'Red BOO-rrels', posted a cryptic teaser for their next project with the caption, "Announcement coming soon."

In December of 2017, Red Barrels posted to Facebook a vague promise of a new game. Though it's been some time, the studio made clear that while a sequel to *Outlast 2* wasn't in development at the time, they were working on something set within the *Outlast* universe. The studio gave precious few details in the 2017 post, but said that the project was something "a lot of you have been asking for." The post also confirmed that *Outlast* would not be getting DLC and that *Outlast 3* would be coming at some point.

The only other hint the post gives about what could be in the works at Red Barrels is the term "distinct experience," which we shudder to think could suggest a VR experience.



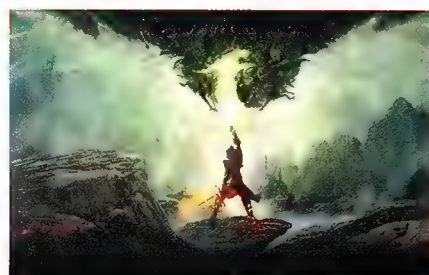
Battlefield 5: War in the Pacific will bring back Battlefield 1942's Wake Island map

Pick up *Battlefield 5 Year 2 Edition* to jump in with some bonuses.

Battlefield 5 has entered the Pacific Theater of World War 2, and if the excitement of returning to classic maps like Wake Island is enough to finally get you into BFS, a new edition of the game can get you caught up quick. The fifth chapter of *Battlefield 5* is titled *War in the Pacific*, and it focuses entirely on battles between the U.S. Armed Forces and the Imperial Japanese Army, neither of which were previously represented in the game.

The new chapter arrives with two maps: Iwo Jima and Pacific Storm, where "the weather is as treacherous as your foes" (try putting that on a tourism brochure). The return of Wake Island will come in December, and EA says it will retain the distinct horseshoe-shaped layout of the original.

On top of the maps, a bundle of new weapons and vehicles have been added to the game for each faction to use, and even more will be up for unlocking as the latest *Tides of War* season progresses.



Dragon Age 4 is "probably" coming in 2022 or later, says EA

THE DREAD WOLF WILL RISE... JUST NOT ANY TIME SOON.

During EA's Q2 2020 fiscal yearly earnings report call, chief operating and financial officer Blake Jorgensen said *Dragon Age 4* will "probably" release after the studio's fiscal year of 2022. This means that April 2022 is currently earliest release date window for BioWare's next entry in the *Dragon Age* franchise.

Xbox All Access brings console rental to the Australian market

THE TELSTRA / MICROSOFT PARTNERSHIP STARTS AT \$27 A MONTH.

Microsoft and Telstra has launched Xbox All Access in Australia, a subscription service that offers an Xbox One console and its Xbox Game Pass Ultimate package for as little as \$27 a month. Paid across a 24 month contract, and with no upfront fee, the service includes access to the huge Xbox Game Pass library as well as Xbox Live Gold online functionality.

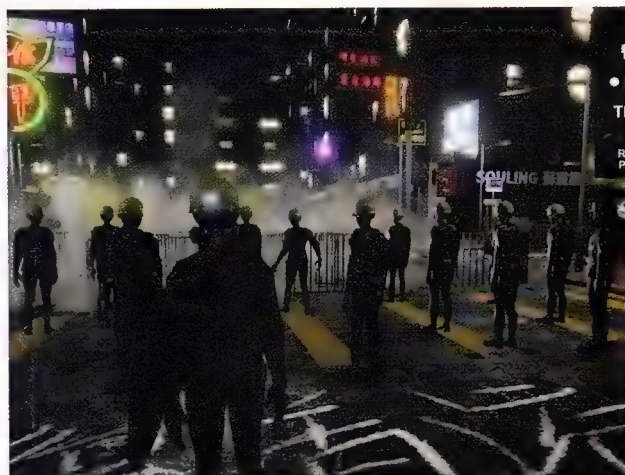
Liberate Hong Kong, the game

IN PURSUIT OF VIRTUAL DEMOCRACY.

A group of Hong Kong activists have come together to develop a VR game, *Liberate Hong Kong*, after eSports athlete Ng "Blitzchung" Wai Chung was punished by Blizzard Entertainment for shouting a pro-democracy slogan during a live-streamed interview following a competition win.

Liberate Hong Kong is a third-person video game simulating current protests in Hong Kong. The game centres on an unnamed Hongkonger as he stays on the frontline of protest, facing the risk of being shot, arrested and other forms of police brutality. The game recreates what it is like to take part in pro-democracy protests in a real street in Hong Kong, in VR.

The game developers have invited Blitzchung to play a demo which was broadcast via Twitch. They have also submitted the game to Steam, though final acceptance of the game for sale is yet to be granted at the time of writing. The game has now been submitted to Itch and will be offered for free.



✓✓✓
apc
RECOMMENDS



\$68 | CALLOFDUTY.COM | PC, XBI, PS4

Call of Duty: Modern Warfare

A new high bar for the series, despite it feeling dated.

This latest sequel/reboot has sold itself as a return to the setting that "started it all". It's a snappy marketing line and it's not entirely misleading. The warfare is once again modern and Captain Price is your squad dad. Yet it's *Modern Warfare's* moments of unfamiliarity that impress me – rebuilt weapon handling, new modes, and characters that aren't the cookie-cutter operatives we've seen in the last decade.

Unfortunately this evolution is only half-realised in multiplayer. Here the relics of 2007 clash with fresh ideas. *Modern Warfare* aspires to be grounded and tactical while also giving you the power to pilot your own heavy gunship, and it doesn't work. It's easy to forget about that complaint in the heat of a match, because *Modern Warfare's* action is

exceptional. Weapons explode with concussive energy and rattle with recoil until the magazine is spent. Reload animations bask in the moment with motion-captured flare that celebrates a kill and snaps back into place for the next fight.

But despite an aesthetic turn toward reality, Team Deathmatch and other core modes remain cyclical meat grinders of kill-die-respawn-kill where the only skill check is the first to click on a head. Oh, and whoever scores the first killstreak. I hate killstreaks. In my years away from the series, I haven't missed getting carpet bombed by a \$90 million jet while minding my own business. Killstreaks hand more power to players already topping the scoreboard, turning the rest of us into ants

under a magnifying glass. And when the roles reverse, the pride of a long killstreak is devalued. I got 30 kills, yay, but really I got 20. The rest are empty ant kills.

The superiority of killstreaks also cheapens *Modern Warfare's* new Field Upgrades – small-scale tools that add a bit of strategy to a standard loadout. Field Upgrades allow for tiny moments of real teamwork, a feat for CoD's typically selfish playstyle.

Gunfight, *Modern Warfare's* new 2v2 round-based elimination mode, is my bastion away from that chaos. Gunfight ditches killstreaks and ratchets up intensity with 40-second rounds and no health regeneration. Every round is a burst of improvised strategy as both teams adapt to randomised identical loadouts. It's simple and

amazing. Within the campaign Infinity Ward has scaled back on thrill rides. It shoots for the variety of distinctive missions that *Call of Duty 4* set trends with, avoiding on-rails murder fests in favour of missions about cautious infiltration where walking is the default move speed.

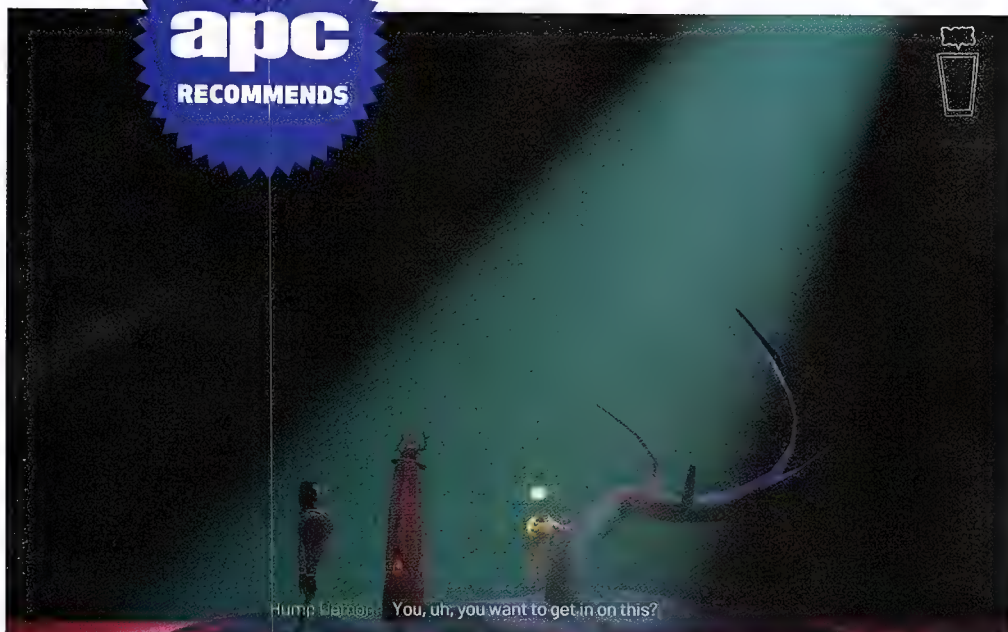
Modern Warfare sets the bar high for first-person gun feel. Gunfight is a standout mode that proves to me *Call of Duty* can slow down and the sky won't fall. ■ Morgan Park

Verdict

Evolves the series for the better, but it could have been so much more.



✓✓✓
apc
RECOMMENDS



\$20 | NIGHTSCHOOLSTUDIO.COM | PC, XB1, PS4, LINUX, MAC, SWITCH

Afterparty

Demons want to have fun and get wasted.

Afterparty is a branching narrative drinking game set in Hell. Our protagonists are Lola and Milo, two recently deceased college graduates and lifelong best friends. With no memory of how they got there, Lola and Milo seek to escape Hell, but the only way home is to out-drink Satan himself. Most of your time will be spent talking and partying with the denizens of hell, with the occasional game of beer pong or a dance-off to mix things up.

As others speak two possible responses appear above Lola or Milo's head. The responses themselves are either positive or negative, agree or disagree. The third option, which changes depending on what drink you're sipping, is usually the most entertaining.

Hell is full of life. The pub talk is entertaining: people of all shapes and sizes walk the streets, the conversations flow smoothly and there's a bar to suit every taste. As you drink your way home and through their interactions with others, you quickly grow to understand Lola and Milo as well as the dynamics



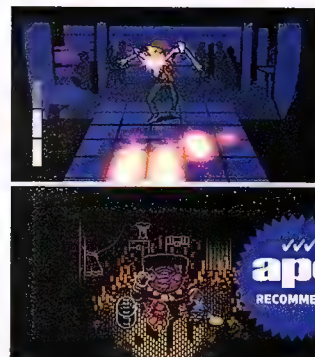
of their relationship. For a game predominantly about drinking, as I played I grew concerned that *Afterparty* was over-glorifying it all. But my concerns were quickly addressed.

It is the definitive night out simulator. You try new drinks, travel between bars, and connect with incredible people. Then, after a few more drinks, things escalate and you start to do progressively stupider things. The repercussions aren't a real concern, it's a bit of fun, you'll be leaving soon anyway. You'll probably never see any of these people again. But inevitably the revelries draw to an end. As a new day arrives they are forced to face reality and their problems. It gets surprisingly sobering.

I had high expectations for *Afterparty*. I was expecting a comedy title, but the very real relationship between Lola and Milo, the humour that had me chuckling and the audacity from Night School Studio to go where they did, at the risk of their player's discomfort, made *Afterparty* more than I thought it could be. ■
Callum Agnew

Verdict

Top-notch writing and superb voice acting, coupled with a visually vibrant hellscape.



Everhood

Rhythm meets roleplaying in musical adventure.

FREE
BIT.LY/EVERHOOD | PC

This Undertale-style adventure deposits you in a familiarly wacky underworld, where a thieving gnome rubs shoulders with an ATM and a boogying Dracula. *Everhood* shines, as a dreamlike adventure that blends genres in a fascinating way. While you're traipsing around each screen, this looks like a typical JRPG.

There are battles, but these take the form of intense minigames against a series of outlandish foes, including that sentient ATM machine, and whatever the hell the final boss is supposed to be. Its minimalism is refreshing with the game stripping away the demeaning busywork we've learned to live with in RPGs. What remains is a procession of duels, interspersed with exploration and enjoyably off-kilter, if a little empty, conversation. And what duels. Similar to *Guitar Hero*, notes rain down from the top of the screen here, coming from the enemy playing – or dancing to – the toe-tapping electro music accompanying each battle. And the setting is intriguing enough that I'm given an incentive to push through its more challenging moments. ■
Tom Sykes



down**time** » game changer

NEED TO KNOW

RELEASED December 17, 2009

DEVELOPER Square Enix

PUBLISHER In-house

LINK www.square-enix.com



Vanille and Sazh, one of the game's main duos.



Final Fantasy XIII

Behind the linearity lies the series' most complex cast.

One of the best lines in *Final Fantasy XIII* is uttered by its narrator, Oerba Dia Vanille, when she says, "Maybe we'd fall short. Maybe we'd never even come close. But someone, someday, would know we'd tried."

These days the anticipation for the *Final Fantasy VII Remake* on PS4 grows stronger with every passing day. The reception for this updated version of the most beloved *Final Fantasy* makes me think of *Final Fantasy XIII* and how its legacy has shaken out in comparison. Like *Final Fantasy VIII* (the only other instalment that can contest it for the title of the most divisive *Final Fantasy*) it took risks and, as a result, fell short of the expectations of many fans. But it's important to know that it tried and that it resonated with many, myself included. I've played most *Final Fantasy* games, and while *Final Fantasy XIII* isn't perfect, as I give it a reinstall and

dive back into it, I'm reminded why it's one of my favourites: namely, its excellent cast.

A FLAWED FAMILY

While every *Final Fantasy* has memorable characters, not every game has succeeded in developing all of them in meaningful ways. *Final Fantasy XIII* strikes a perfect balance; the cast is large enough to form a web of dynamics that continuously develop in fascinating ways, while small enough that everyone gets considerable screen time and complexity. The game's characters are its pillars, especially given its infamously tricky to follow story.

Final Fantasy XIII follows a group of six people who are branded L'Cie, beings who must serve demigods known as the Fal'Cie. Becoming L'Cie seals their fates; if they don't complete their

Focus they become ghoulish husks known as Cie'ths. If they do complete their Focus, they are crystallised and can only be restored to their mortal forms under specific circumstances. Together they set out to fight the Sanctum government, which is purging L'Cie, and figure out their Focus. At the beginning the exposition dumps lore and terminology on the player without spending much time to explain it all, and this is one of its flaws. However, once you take the time to really understand them, the game rewards you with a story led by what is still the most nuanced and interesting cast in the series' history.

The game achieves this feat through constantly changing the makeup of your party and having you play as everyone despite Lightning being the protagonist. It splits up specific



Lightning Farron, the protagonist of Final Fantasy XIII.



Also a game of extremely nice coats.



The main cast gathers together at a pivotal moment.

characters whose narratives depend on each other into pairs, developing them as compelling individuals and partners in the process. Later on these duos join up to become a larger group that stands together throughout the many revelations and hardships that plague their journey. The events of the story force them to come to terms with their flaws, face the consequences of their past and present mistakes, and have the difficult conversations that gradually change them into better, more complete people.

Lightning resembles Cloud and Squall in that she's a no-nonsense soldier who deeply struggles with emotional vulnerability. Following his mother's death, Hope is a teenage boy who gets caught up in a war he never wanted to be part of. Through his tendency of proclaiming himself as a saviour to mask his insecurities and failures, Snow is a play on the classic hero archetype. Fang is a Dragoon who wields sarcasm, cockiness, and assertiveness as expertly as her lance; a type of character that isn't assigned to women in

JRPGs often. Sazh is a kind and devoted father dedicated to saving his son and, even now, a rarity among JRPGs as a black main character who's written like a person rather than a caricature. Vanille is a subversion of the happy girl archetype, utilising a bubbly facade to mask the cynicism and darkness that lurks underneath.

It's not easy to immediately see how intimately these characters are connected to each other. But by the end, this group of wildly different individuals united only through their base mission of escaping persecution becomes a

FABULA FANTASY The Fabula Nova Crystallis series titles



FINAL FANTASY XIII
The first game in the XIII trilogy, released in 2009.



FINAL FANTASY XIII-2
A direct sequel to XIII that was released in 2011.



FINAL FANTASY TYPE-0
Released in Japan in 2011, 2015 internationally.



LIGHTNING RETURNS: FINAL FANTASY XIII
The finale of the XIII trilogy.



FINAL FANTASY AGITO
Set in Type-0's world, released in 2014 for Japan only.



FINAL FANTASY XV
Loosely adopts the FNC mythos from its past as Versus XIII.



FINAL FANTASY AWAKENING
First released in China in 2016, other regions followed.



family that knows the flaws and virtues of its members.

PARADIGM SHIFTS

Next to *Final Fantasy XIII*'s linearity its most controversial aspect is the battle system. Its core concept is switching between Paradigms, specific classes you assign to each character. Every party member can access every one, but each is most well-suited to certain classes. You have a limited number of slots for Paradigms, so you have to envision various situations in advance to prepare yourself.

You might want to start a boss battle with a Commando and two Ravagers to build up and maintain a stagger percentage on them. If you're low on health after a devastating attack, you'll want to rapidly switch to a Paradigm composed of two Medics and a Sentinel to heal up your party and enhance defences. While you'll spend a significant time using the Auto-Attack command between Paradigm shifts, different situations call for different Paradigms,

so the system isn't as passive as you might assume. It requires you to think on your feet and to do so quickly.

It's strategic, but in an admittedly unorthodox way. Against challenging enemies, it can be really good fun. Just as you're not bound to playing just one character, you're not restricted in the classes you can assign to them – so if you want to make tiny 14-year-old Hope into a Sentinel who stands firm on your frontline, you can.

THE PROMISE

One thing that helps define all Final Fantasy games is the quality of their music. There's a reason why tickets for Distant Worlds, the Final Fantasy orchestra concert, often sell out as it tours venues all across the world.

While most soundtracks in the series have been primarily composed by the iconic Nobuo Uematsu, Masashi Hamauzu takes the rein on *Final Fantasy XIII*'s.

Yet I'd go as far as to say it's the best in the entire series, with the

soundtracks for *FF VIII* and *FF XIV: Shadowbringers* being the only possible contenders for that illustrious title. The soundtrack is as diverse as the locations you'll travel. Some, like *Blinded by Light*, are thrillers that trigger a surge of adrenaline that gets you on your feet in the middle of battle; some, like *The Promise*, have beautiful piano accompaniments, perfect for relaxing or studying; and some, like *Dust to Dust*, are so wistful and magical that I struggle to convey the feelings they stir in me in words.

Final Fantasy as a series is never an easy one to summarise, and that's in large part due to atypical entries like *Final Fantasy XIII*, *Final Fantasy XII*, and *Final Fantasy VIII*. While the latter two are generally remembered more fondly, it's *FF XIII* that solidified my love for the series. In being the first high-def Final Fantasy, it was eager to take risks that most sequels wouldn't dare commit to. Time hasn't dulled that rebellious spirit in the least. ■





Mushroom Hunt

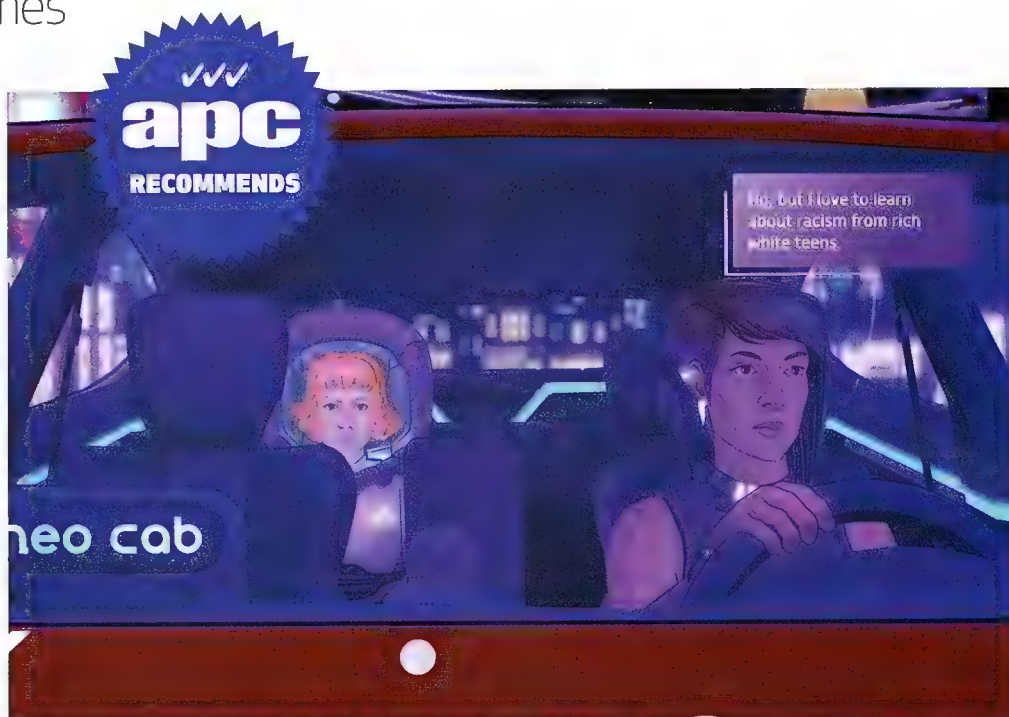
Be a fungi.

FREE | POLYDUCKS.ITCH.IO/MUSHROOM-HUNT | BROWSER

While most text adventures these days take the form of branching narratives where choice is your primary interaction, *Mushroom Hunt* harkens back to ye old days, offering the player a puzzle challenge that will test their lexicon and powers of observation.

While many text adventures have you thinking on grand terms, as you try to survive in a hostile fantasy realm or attempt to solve a murder mystery, here you're primed – on your mushroomy quest – to look in bushes, and around trees, and under piles of discarded junk for edible puffballs. It's mostly a case of examining or taking things here – the list of useable verbs is actually quite small – so this would be a good gateway game for those wanting to give parser-based interactive fiction a try. Not least because of the attractive ASCII art that accompany each of the environments on screen.

As you find the three required mushrooms – and, perhaps, the many other secret ones – you'll also uncover scraps of backstory, hints of your own history and that of your grandma and granddad. ■ Tom Sykes



\$21 | NEOCABGAME.COM | PC, MAC, LINUX, SWITCH

Neo Cab

Paints a picture of a not so far future.

Lina is ready to start a new life. When you meet Neo Cab's protagonist, she's en route to Los Ojos, a fictitious city reminiscent of Los Angeles. Her taxi holding the last of her belongings, she sets out to reconnect and move in with her best friend Savvy. When Savvy disappears, Lina is all alone in 'Automation City', left to juggle the demands of her job, her mental state, and the mystery surrounding the person she thought she knew best.

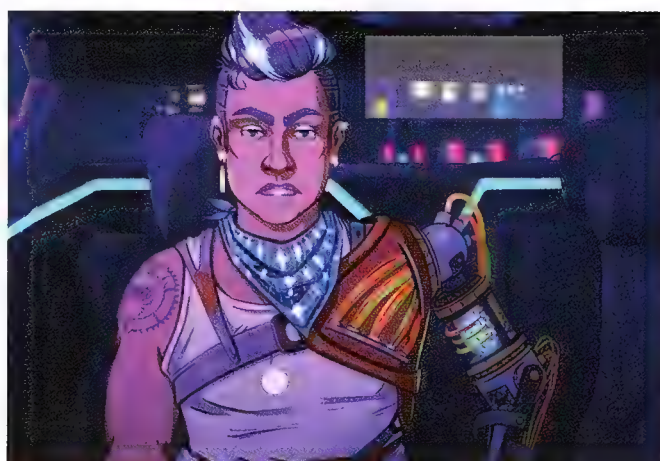
Lina has to ferry a certain number of passengers, called pax, to their destinations each night, and keep enough money to

herself to find a place to sleep. However, technology plays a huge part in each encounter, as everyone she meets is using or affected by some gadget. The future Neo Cab paints may seem slightly dystopian, but it skilfully speculates that we're not as far from our very own version of automated cities as we may think.

Over the course of a week you pick up different passengers each night and have a chat with them during the ride. The quality of your talk doesn't only determine whether you get a tip or not, it's also absolutely crucial for your

driver rating. You have to maintain a rating of four stars or higher or you risk a deactivation warning. Failing to raise your rating theoretically ends the game (though I tried doing as poorly as I could and still didn't actually hit a game over state). Chance Agency was inspired by the rating real Uber drivers have to maintain, and playing the game you notice very quickly how devastating it can be to get anything but a perfect score from a passenger – though my seeming inability to truly fail undercut that feeling somewhat.

The writing is atmospheric throughout, but Neo Cab's greatest trick is that I can't tell whether everything that seems a little fake to me – the overly philosophical conversations, me questioning every kindness – was purposefully designed to feel that way. ■ Malindy Hatfield



Verdict

An intriguing and thoughtful cyberpunk mystery.





\$69 | OUTERWORLDS. OBSIDIAN.NET | PC, XBI, PS4, SWITCH

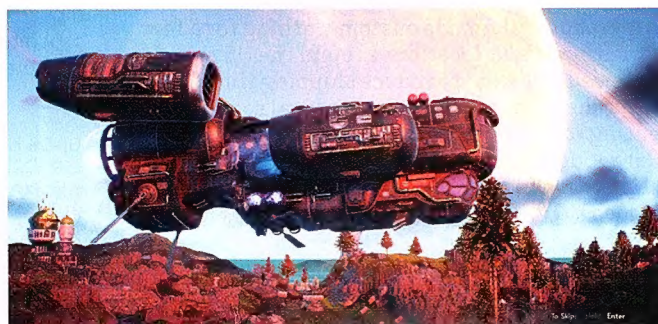
The Outer Worlds

Take a breezy tour of the Halcyon system.

The Outer Worlds is a light-hearted RPG that aims to emulate the *Firefly* fantasy. You fly from planet to planet, gather a crew of misfits, pick your way through a series of moral quandaries, and shoot people with laser guns. The game's aesthetics and dark sense of humour pitch *The Outer Worlds* against Bethesda's *Fallout* games, but there are important differences. True, you have ray guns and companions who shoot enemies for you, but this game isn't a sprawling sandbox experience.

You hop between planets and space stations, exploring fairly large zones full of corporate employees staving off plagues and wild animal attacks. Each area is loaded with loot and sidequests, but it's a tight and prescriptive RPG. That's not a bad thing, but in a world of 70-hour RPGs it's best to set expectations. *The Outer Worlds* is a pulpy choose-your-own-adventure experience. If you don't go in expecting a deep systems-driven sandbox, it's a pleasure to go through.

Combat isn't challenging and enemies fit into worn



categories – face rush melee types, sniper types, dog types. But the *Jetsons*-style sci-fi weapons are fun to use and battles are frequently hilarious. Enemies explode into chunks with enthusiasm, often while screaming overwrought barks.

Fights exist to put some light friction between meetings with *The Outer World's* oppressed but surprisingly merry citizens. The corporate colonies are full of employees keen to do the best job they can – largely because getting fired can mean exile and death. The story winds between pockets of people trying their best to survive. The game's main dilemmas ask you to side with one faction against another. You're free to play the freedom fighter

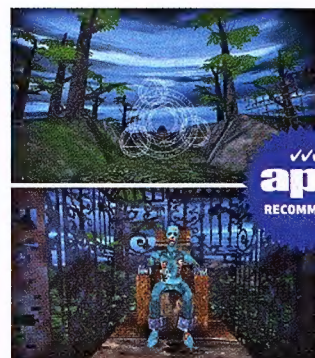
or a corporate shill, but quest outcomes are frequently messy and unexpected. Along with multiple endings, that gives the game some replayability.

It's a fun journey. The advantage of the planet-hopping structure – rather than having a single contiguous wasteland to explore – is variety. It's a colourful universe full of lumpen spaceships that remind me of *Red Dwarf*.

■ Tom Sykes

Verdict

An entertaining and uncomplicated RPG set in a colourful yet dystopian universe.



Penitent Dead

Make friends with Zombies.

FREE | LOVELYHELLPLACE.ITCH.IO/PENITENT-DEAD | PC, LINUX

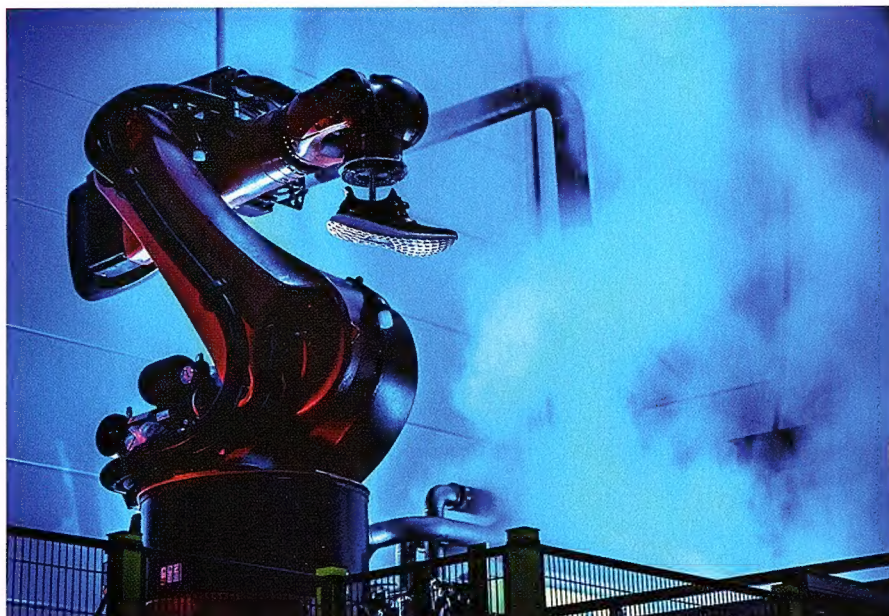
You can't move for *Dark Souls* clones these days, but where are the games inspired by its super-niche predecessor? I may have answered my own question there, but at least we finally have a candidate in the form of *Penitent Dead*.

There's really only one reason to play this, and that's for the majestic setting. It's as if a doom metal album cover has been fed into a 3D modelling program, and output at the wrong resolution. Nostalgia aside the ambiguous and jittery nature of the PlayStation aesthetic does much to enhance the low-polygon 3D models and blown-up textures. The already striking artwork feels richer and more tactile. It's just a shame that the era-authentic soundtrack cuts out almost immediately.

He's surprisingly chatty for a zombie.

While there are few locks and keys to manage this is a simple exploration game, which you can end almost whenever you want, just by walking through a door. No matter the sights of the island, or the tantalising scraps of lore, the game ends a bit flatly as a result. ■ Tom Sykes





Asian robots are stealing American robot's jobs

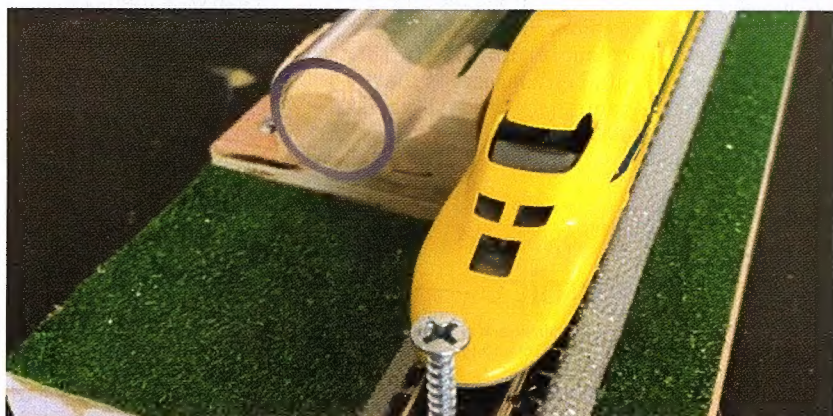
"They took our jerbs!"

Adidas has been experimenting with robotically-made custom clothing for a few years now, opening up micro-factories in various locations around the US and Germany. The intent was for these 'Speedfactories' to reduce shipping time and reduce the risk of exploitative supply chains by using high-tech local robots. However, after years of experimenting with this system it was found to be too slow and expensive to be viable. Rather doing away with built-to-order product lines, Adidas has flagged its intention to move its robotic manufacturing to Asian facilities by 2020, where it can produce a wider range of custom garments for less.

13-year-old designs an underground transport system better than Hyperloop

3M YOUNG SCIENTIST CHALLENGE ENTRANT OUT-THINKS ELON MUSK.

Elon Musk's ambitions to make reusable space rockets and self-driving electric vehicles has put him on the shortlist for Time magazine's Person of the Year multiple times. Musk's next big idea is to revolutionise the everyday commute with an intricate transport system called a Hyperloop. The problem is it was recently overshadowed by an even better version, proposed by a 13-year-old. The revision suggests that a vacuum tube propulsion system running parallel to a traditional train track, connected via a magnetic arm, would make the Hyperloop system safer (people aren't trapped in an airless tube) and more economically viable.



MIT wants poo selfies for AI bowel diagnosis training

SEED-Y PROJECT SEEKS TURDS FOR SCIENCE.

AI has been trained to analyse a lot of information over the last couple of years, but a collaboration between microbial health research company Seed and MIT hopes to use poop pics to train AI to analyse and detect chronic bowel diseases and syndromes. The project is asking people to 'give a shit' for science, with the hope of collecting 100,000 real-life pooojis in what will be the world's largest known data 'dump'. If you want to contribute your own turds to science, take a pic on your phone and upload it to **seed.com/poop** along with the timing of your movement and an email. Seed has stated it separates pics from the metadata to prevent any potential poo shaming.



Amazon PR confirms existence of fictional automated fulfilment centres

OFFICIAL RESPONSE BLUNDERS BY ACKNOWLEDGING CONTENTS OF INVENTED SATIRICAL OP-ED.

The *New York Times* is running a collection of fictional opinion pieces titled Op-Eds from the Future, the most recent of which is a piece titled "Amazon's First Fully Automated Factory Is Anything But". While this story about how Amazon's first autonomous-factory is not in any way true, another tech journalist colleague reached out to Amazon's PR for comment and, for some inexplicable reason, Amazon's PR responded. In addition to appearing to confirm the existence of the facility by stating that "We [Amazon] consistently pilot new technologies", it then defended the non-autonomous autonomous-facility by claiming that it exists to increase safety, 'speed up delivery times' and add 'efficiencies'. ■

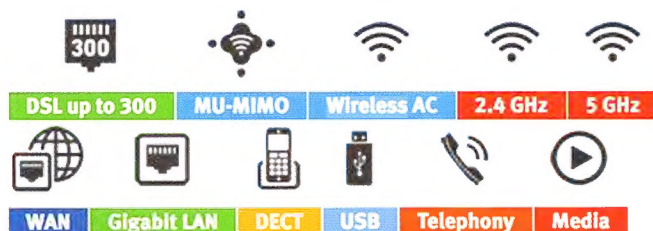
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acer



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